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and

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Antiquity of Cast Iron

It seems now definitely established that iron castings had their origin in China and not in Eastern Europe, as was formerly believed. The date usually given is the 14th century for Europe and early 15th century for England. Now, however, there is evidence that China was making iron castings certainly as early as A.D. 1,000, and possibly as far back as the 3rd century A.D. Not all these entered into the "art" category, for some of the oldest were stoves. Much light has been thrown upon this subject in a Paper read before the American Institute of Mining and Metallurgy by Maurice L. Pinel, jun., Thomas T. Read and Thomas A. Wright, who dealt with the "Composition and Microstructure of Ancient Iron Castings." They examined nine specimens, seven of which were art castings, one was labelled "flying scissors," and the last was a cast-iron stove. The "flying scissors" is a casting, but the purpose of it is quite unknown. It weighs more than half a ton and measures three feet by six feet, and takes the form of an elongated curved cross or copy-book capital X. A fanciful idea is held that China once had a heavy engineering industry at the time when the rest of the world was in the bronze age. If this be so, one could imagine that such a casting would be used for anchoring machinery.

Most of the castings had their date of casting, as, for instance, the Chinese equivalent of April 30, A.D. 550, stamped upon them. Obviously this sort of marking could be easily faked, but fortunately in this series there is not only Prof. Read's guarantee, but also documentary evidence. The reason for China's supremacy in the matter of making castings at such an early date was the invention of the double-acting box bellows. This machine certainly placed them in a much better position, metallurgically, than if they had only the elementary contraptions used by the primitive races. From the point of view of a good engineering cast iron, the composition of the castings reveals that there was a steady deterioration throughout the years covered, that is, from A.D. 502 to 1093. The composition of Specimen No. 2 (A.D. 508)—T.C, 3.22; C.C, 0.96; Si, 2.26; Mn, 0.23; S, 0.077; and P, 0.17 per cent.—shows it to be a good pearlitic cast iron, with manganese a little on the low side. Moreover, Specimen No. 1 was a little higher in combined carbon and still lower in manganese. The later specimens deteriorated from an engineering point of view, and in at least three cases were white iron, whilst the intermediate ones were distinctly ferritic.

The method of moulding, according to Prof. Read, was by carving rammed sand, and so dispensing with the need for a pattern, or by using the modern method of building up the moulds with cores. Terra-cotta moulds were used in China for making brass coins as early as the year A.D. 7, and a specimen of one of these exists in the British Museum. The foundry industry is indeed indebted to Prof. Read, of Columbia University, and his colleagues for their scholarly researches into the antiquity of iron castings.

The Metallurgical Nursery—II

We referred last week to the comparatively small number of men taking university courses in metallurgy in this country. There is no doubt, of course, that some men who take degrees in chemistry and to a lesser extent in physics and other subjects find their way into the metallurgical industry, but this is probably balanced, if not more than balanced, by the number of metallurgically qualified men who enter the chemical and engineering as distinct from the metallurgical industries. Indeed, professors of metallurgy might render a useful service by analysing for, say, the past ten years what proportion of their students are in productive industry and what proportion in teaching, research and other posts.

One of the great difficulties is that when a depression exists there is no demand for men, and consequently entries to courses are smaller. By the time a three or four year course is finished the situation has changed and there is a great demand for the few available. Industry can do much by indicating what its probable demands are from year to year, and by taking a long view with respect to trained staffs and trade fluctuations, because some time inevitably elapses before a man is sufficiently familiar with conditions to be fully productive, and the best time to create a nursery of men is when conditions are not good and a greater choice is practicable. The conduct of research by post-graduate students has done much to enable them to keep going until they can be absorbed by industry, and it is astonishing how much can be done in this way with comparatively small sums.

Finally, we again urge both prospective employers and students to extend the practice, common in the engineering industry, whereby a man takes a practical apprenticeship in a works before seeking a staff post. This repairs what is usually the biggest gap in his experience, but above all it gives the employer a chance to see what a man is like in the ways so important in industry and not readily assessed by examination—sense of discipline, common sense, ability to work with others, and so on.

Hours of Employment

THE CONVENTIONS ACT

A singular feature of the Hours of Employment (Conventions) Act, 1936, is that, although passed as long ago as July 14, 1936, it only came into operation on January 25 of this year. The delay arises from the fact that the measure is one which has arisen from a general conference of the International Labour Organisation of the League of Nations, and applies internationally, that is, so far as the nations consenting to the Conventions are concerned. Therefore, ratification by each government is required before the Conventions are applied.

To understand the Conventions adopted by this country, it should be noted that this 1936 Act concerns the employment of women (of any age) and amends the 1920 Act, the other provisions of these Conventions Acts applying to the employment of young persons (males and females under 18 years) and to children. The employment of a boy or girl under fourteen in an industrial undertaking is entirely prohibited. The term "industrial undertaking" is comprehensively defined in the Acts.

The Acts provide that ordinarily no woman or young person must be employed during the night; that is, there must be a non-working interval of eleven consecutive hours, and these eleven hours must include the interval between 10 p.m. and 5 a.m. If the business is a family one, meaning one where only members of the same family are engaged, the Acts do not apply.

As regards women, it is laid down that night work can be performed in cases of *force majeure* when there occurs any interruption of work which it was impossible to foresee and which is non-recurring, or in cases where the work has to do with raw materials or materials in course of treatment which are subject to rapid deterioration, when such night work is necessary to preserve the said materials from certain loss. Also, in a seasonal business the night period may be reduced to ten hours (instead of eleven) on sixty days of the year; this rule can also be claimed in all cases where exceptional circumstances demand it.

This new Act makes clear that the provisions governing employment of women only apply to ordinary manual workers; that is, the Acts specifically exempt from the hours obligations (as incidentally does the new Factories Act) any woman who holds a responsible position of management and who is not ordinarily engaged in manual work.

The rules prohibiting night work in the case of young persons can also be suspended (if the employee is sixteen years of age) in cases of sudden (not occurring periodically) emergencies which may interfere with the normal working of the business, or by the government concerned, when in a case of sudden emergency the public interest demands it. Furthermore, night work is permitted in the case of young persons (who must be sixteen years of age) in certain named undertakings, on work which, by reason of the nature of the process, is required to be carried on continuously day and night. Included in the list of specified undertakings, as just mentioned, are the following of interest to the foundry industry: the manufacture of iron and steel; processes in which reverberatory or regenerative furnaces are used, and galvanising of metals (except the pickling process).

These Acts require registers and the like to be kept, as under our own Factory and Workshop Acts, but it should be noted that the observance of the rules of these measures meets the requirements of these Acts governing the Convention. Such Conventions Acts are in addition to, and not in derogation of, any of the provisions of any other Acts limiting times of employment, but national Acts do not run counter to those provisions, so conforming to our own measures is compliance with the others.

Notes from the Branches

Falkirk Section.—At the last meeting of the Falkirk Section of the Institute of British Foundrymen, Mr. James M. Primrose (managing director of the Grangemouth Iron Company, Falkirk) announced a novel and useful method of aiding the funds of the local infirmary. He is now engaged in writing a "History of Ironfounding in Falkirk," to be published at his own expense, and he intends handing over the entire proceeds of sale to the infirmary officials.

The book will be of great interest to the ironfounding industry. It will deal mainly with happenings in the Falkirk district, which has long been recognised as the home of the light castings industry. Mr. Primrose, in his work of collation, has been promised the assistance of several well-known local gentlemen, including Mr. George Pate (Carron Iron Works); Mr. George Scotland (Falkirk Foundry); Mr. William Wright (Burnbank Foundry), and Ex-Provost Logan, of the General Ironfounding Association, who have each had a life-long association with the foundries. The book will abound with anecdotes, and will also portray some of the old craftsmen and "characters" who worked in the moulding shops.

Mr. Primrose, who was the principal speaker at the meeting, traced the history of ironfounding from China, through Europe, to Scotland. The real progress in the light castings industry, he declared, was made in Scotland, especially at Carron. It was a fact to be proud of that there would probably have been no steamship or steam engines had there not been a Carron Company. It was there that Symington and Bell had the castings made for their engines.

It was announced with regret that Mr. H. McNair was resigning his duties as secretary, as he was shortly to take up an appointment in England. It was also intimated that Mr. H. Cowan, the Chairman, would follow suit very shortly. Both gentlemen were warmly congratulated on their appointments, and were thanked for the services they had rendered to the Section.

Correspondence

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Esperanto

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I was interested to see in the January 20 issue of the JOURNAL a reference to the international auxiliary language, Esperanto. It may interest your correspondent to know that the writer of this letter, an estimating draughtsman with some years' experience of foundry work, has used Esperanto for international correspondence with engineers in other countries for a few years, and in addition has spoken it with many nationalities, including Poles, Japanese and Czechs.—Yours, etc.,

THOMAS GLOVER.

"The Nook," Manor Way,
Pett's Wood, Kent.
January 31, 1938.

Defects in Chilled Rolls

MR. B. RAMASESHIAH, Foundry Superintendent of the Mysore Iron and Steel Works, Bhadravati, has asked us to express his thanks to the various readers who wrote direct to him in connection with his query on chilled rolls which was printed in our issue dated November 25, 1937.

Random Shots

Amongst the many curious things which people collect are horse "brasses," and these, apparently, can hold their own against stamps, old coins, and even firebacks as objects of historical interest. It appears that they were brought into England at a very early period by invading tribes, and the designs in every case show the Oriental influence, representing different forms of sun-worship. Seemingly the very ancient ones have almost completely disappeared because they were made in perishable materials, and it was not until the early nineteenth century that they were regularly made of brass. Could not an exhibition of these cast curios be arranged during the next International Foundry Congress? No doubt Mr. Roy Stubbs would lend his personal collection and provide some literature on a subject less familiar to foundrymen than firebacks and bells. A correspondent in the "Sunday Times," the Rev. Hubert Stanley, of Marshfield Vicarage, Cardiff, claims to have the largest collection in the kingdom, and offers to show it by appointment to any interested amateur. He would doubtless give a warm welcome to any foundryman who would care to see his collection.

* * *

Incidentally, it is surprising how popular stamp collecting is amongst foundrymen. It certainly has one advantage over golf as a hobby; there is no age at which one cannot indulge in it. At one end there is a picture of a very absent-minded but dear old gentleman who held up the Christmas Post Office queue quite considerably because he couldn't find any hinges in his pocket to put the stamps on his parcels. At the other extreme is the picture of one reader's very small daughter who has caught the enthusiasm of her father, but has invented her own special jargon. A stamp to her is "fringed," not perforate. When it has been floated off, then it is without its petticoat. An overprinted stamp is "translated," and one that has been perforated with a firm's initials is "vaccinated."

* * *

The Falkirk section of the I.B.F. holds its meetings in a temperance café! "Marksman" cannot help but wonder if they really prefer the familiar atmosphere of joggling fish plates to the noise of clanking beer mugs? Or is it just another attempt to deceive the wife as to the true nature of their "goings-on"?

* * *

Fancy that! After all these years of study and scientific research it has just occurred to metallurgists to put a pinch of salt on the coke. It only remains to put the pepper on the pig to get a really well-seasoned tapping. . . . A little mustard might help, too.

* * *

The Institute of Metals has wisely decided that all work and no play makes Jack a very dull boy, for they are returning this year to the former habit of dancing after the Annual Dinner in London. To trip a pretty measure occasionally is good for the soul as well as the liver, and the foundrymen, at least, are becoming very hearty supporters of that theory.

"MARKSMAN."

Higher Wages for Cleveland Blast-furnacemen

Dating from the first Sunday in February, Cleveland blast-furnacemen will enjoy an advance of 5 per cent. in their wage rates. It may be recalled that in December last a new agreement was reached, substituting the value of basic for No. 3 Cleveland iron as the datum line for the fixation of wages at the ironworks. The immediate effect was to raise the blast-furnacemen's wages by 6¾ per cent., and this further advance of 5 per cent. which will operate for the next three months means that all base and bonus rates will carry an additional percentage of 46.75.

Design in Relationship to Contraction and Distortion*

By E. LONGDEN

It is not intended to enlarge greatly on the associated phenomena surrounding contraction of metal and its effects on distortion and strength in castings generally, but briefly to refer to design as it affects a certain class of castings only within the ambient of this essay. Although the author has devoted considerable time to the study of distortion during the past 10 years, he is only just beginning to understand a little and realise that only the fringe of the subject has yet been explored by anyone connected with the scientific or practical aspects of the foundry.

FIG. 1.—VERTICAL FRACTURE IN A PLANING MACHINE BED.

New Thoughts on Design

Any consideration of design by a designer to help the foundrymen is fraught with some difficulty. There is much that can be done by rational co-operation between the designer and the foundry through the medium of the pattern-shop to eradicate many obvious errors of design. In this connection, tribute must be paid to designers in general. They are always ready to change a shape or re-design a section to suit the metallurgical and manufacturing difficulties of the foundry. Within their knowledge they often anticipate foundry difficulties. Without "whitewashing" the designer, it is emphasised that if foundry manufacture was covered by mechanical operations as in engineering, executives would have fewer hazards and responsibilities in the foundry. The more the experience of the modern machinist and fitter, the better the appreciation of the designer.

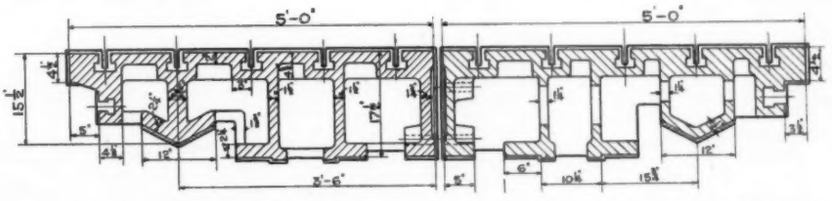


FIG. 3.—(LEFT) NEW AND IMPROVED DESIGN AND (RIGHT) DESIGN OF THE PLANING MACHINE BED WHICH FRACTURED.

FIG. 2.—EXTENSIVE HORIZONTAL FRACTURE IN A PLANING MACHINE BED.

Can one always state clearly to the designer what one needs to secure the best results in a casting? Founders are all familiar with the parrot-cry of "the design is not uniform." A uniform design is not the solution to foundry difficulties in relationship to fluid shrinkage, contraction and distortion, because one cannot secure a uniform cooling rate in a mould. External parts of a casting will cool before the inner parts for the same section of metal. The admission of metal to any particular part of a mould will create differing temperature gradients and cooling rates, although the same section may exist all over the mould. Nor can the designer help much in overcoming the resistance met by the contracting metal on enclosed cores and its effects on contraction and distortion.

One could design and make a casting which would conform to a safe cooling rate, but would this design suit the duty of the machine? Of course not, in most cases. However, one must impress on designers two fundamental rules:—(1) *Wherever permissible, allow thicker sections on the outer body of a casting than on the inner sections;* and (2) *avoid changing a section abruptly.*

Fig. 1 shows the two halves of a heavy-duty planing machine table weighing about 35 tons, which failed in service due to distortion and fracture because of faulty design or ill-usage, or both. The table, by the way, had not been made by the author's company, but they were commissioned to replace the table.

Fig. 2 illustrates how each half-table fractured during service. The upper half-table shows that the fracture extends longitudinally for about half the length of the casting along and below the vee box-shaped slide-way. The slide-way is also fractured across the section. The other half-table is fractured longitudinally below the slide-way for approximately 95 per cent. of the total length of the casting. In addition to the fractures, the castings had distorted considerably. The centre joint of the two castings showed that distortion had taken place sideways to the extent of being $\frac{1}{16}$ in., full in the vertical middle—when together, $\frac{1}{64}$ in. feelers could be placed in the gaps between the joint at each end of the table. Each half-table was also hollow across the centre on the heavy tee-slotted side shown face downwards in Fig. 2.

Why large iron castings of this class fracture in the way they do can be largely explained by reference to charts which have been prepared showing the behaviour of a bedplate and simple bars during cooling. It would appear from an examination of the fractured tables that during cooling the thinner box section forming the slide-way would cool much earlier than the very heavy reverse face of the table. The contraction of the upper slide-ways and sections would be taking place against resistance offered by the much slower cooled bottom surface of the casting. Thus in the early stages the upper surface would undergo extensional stress whilst in a milder way the lower surface would undergo compressional stress. On final cooling the heavy bottom section on taking up its shorter length will now place the top in extensional stress again by an upward or bending moment. During contraction the ends move downwards so that the stresses set up are dual and conflicting. Again at an early period the top suffers extensional stress whilst the bottom is affected in

D

* Paper read before the Scottish Branch of the Institute of British Foundrymen, Mr. E. J. Ross presiding.

return by a mild compressional stress; later the top is subjected to a further extensional stress by bending or bulging and the bottom to extensional and bending stress.

The fracture in the half-table shown in Fig. 2 is open $\frac{5}{16}$ in. in the centre, which indicates that the lower heavier face has thrust the top upwards, thus extending the face. To accommodate itself the slide-way must either break across or part from the lower face metal by ripping under the slide-way longitudinally, and bending to take up a shorter length.

Fig. 3 shows a cross-sectional sketch of the old and new design to overcome somewhat the troubles outlined. The right-hand half of the drawing shows the old and faulty design, and the left-hand side the improved design.

The light box-shaped design for the slide-way was abandoned for the heavy arrow-head shaped design on the left. The extra metal introduced into the upper slide-ways and inner vertical walls was counterbalanced by a reduction in the metal forming the opposite face of the table. Fig. 4 shows the newly-designed and assembled table ready for despatch.

CONTRACTION TESTS

Simple Bar Castings

Contraction phenomena encountered in castings holding contrasting sections disclose in the type of casting investigated by the author that the thicker sections contract more than the thinner sections. So far as cast iron is concerned, this is quite contrary to the known behaviour of the metal, that the thinner the section, the finer and closer is the structure, consequently the greater the contraction.

Referring to Fig. 5, which is a test casting holding varying sections held together in the form of a grid, contraction takes place as exaggerated in the Sketch D. If the bars are separated from association as a grid or frame, contraction takes place as normally understood; the thinner the bar, the greater the contraction.

The graphs of Figs. 6 and 7 show the cooling behaviour of three bars 1 in., 2 in., and 3 in. in thickness by 8 in. in depth and 32 ft. in length. The bars were poured at the same time as the 32-ft. long bedplate described in the graph, Fig. 8, from metal of the following composition:—Total carbon, 3.22; silicon, 1.48; manganese, 0.83; sulphur, 0.11, and phosphorus, 0.79 per cent.

FIG. 4.—REDESIGNED PLANING MACHINE BED.

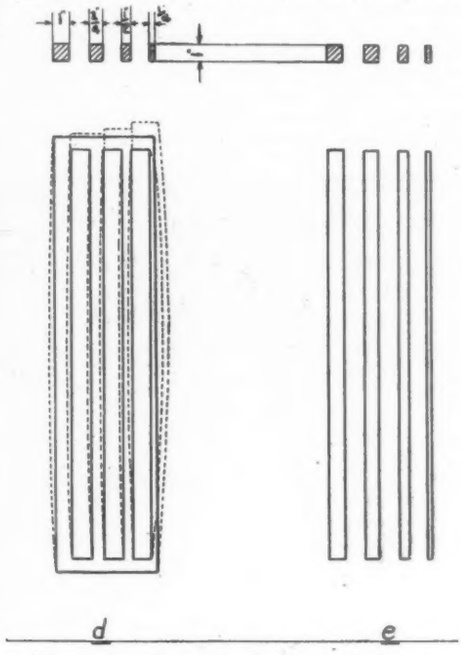


FIG. 5.—TEST GRIDS FOR ASCERTAINING THE EFFECT OF CONTRACTION.

Test Procedure

These tests are typical of a number taken by the author on the contraction and distortion in large castings of the bedplate design. The evidence amply confirms the phenomena noted in the small grid test casting.

The test procedure is as follows:—During the ramming of the moulds heavy weights are bedded outside the ends of the pattern at approximately 4 ft. distance. Wrought-iron

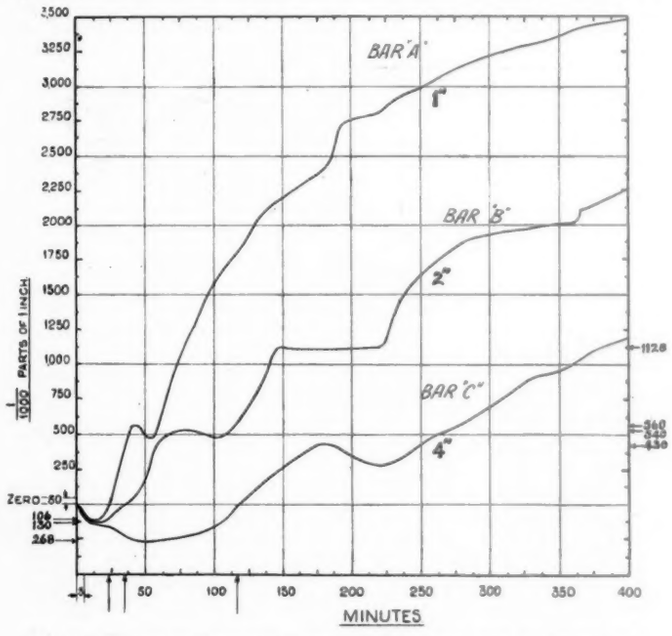


FIG. 6.—GRAPH OF THERMAL HISTORY OF SIMPLE BAR CASTINGS OF INCREASING SECTION, EARLY STAGES.

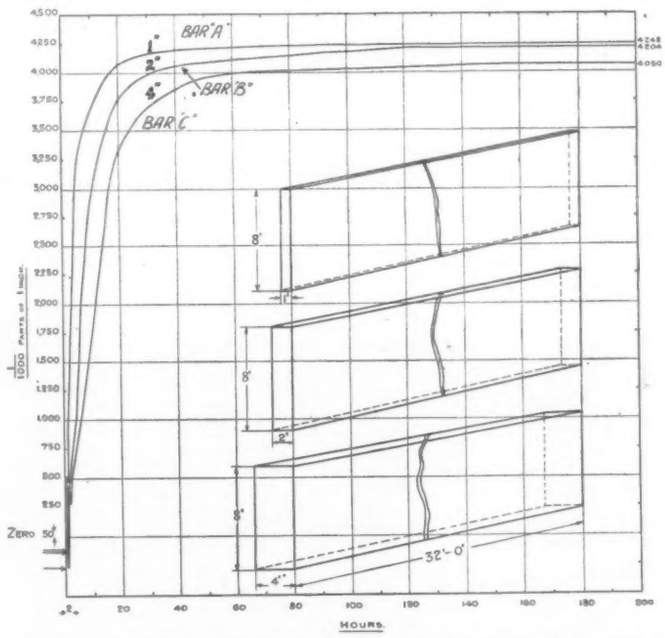


FIG. 7.—THERMAL HISTORY OF SIMPLE BAR CASTINGS, EXTENDED TO EMBRACE OVER EIGHT DAYS.

tubes 3 ft. 6 in. in length are also positioned and rammed up along with the mould, the ends being located within 1 in. of the face of the casting and the other ends about 4 in. away from the vertical face of the weight. In the case of the simple uniform bars, provision is made for only one tube located opposite the centre of the 8 in. depth. In the case of the bedplate, however, four tubes are located at each end, two opposite the heavy shears or slide-ways at each end, and two at each end two inches from the top face of the mould and opposite the top of the vertical walls of the casting; there are eight tubes in all.

After withdrawing the patterns from the floor and the finishing operations, the moulds are broken through at the ends opposite the tubes and ½ in. wrought-iron rods pushed forward to within about 2½ in. of the face of the heavy weights. About 1 in. of the rod, jagged to hold in the metal, penetrates into the mould. The other end, which has been ground perfectly flat, corresponds with crossed centre-lines scribed on a polished section of the weight. The ends near the mould are well sealed and secured by solid ramming.

Before the pouring of the casting careful measurements are taken by inside micrometers of the gap between the end of the rods and the centres marked on the weight. Provision is made to begin taking measurements within five minutes after the mould has been poured. Continued measurements proceed for about two hours at 5 minute intervals, when the measurements are slowed down to every 15 minutes for a further two hours and every three hours for about 48 hours, and then four times per day until contraction is complete. The total rate of contraction is shown by the final gap distances less the original gap dimensions before pouring the castings. The sum of the net gap dimension at each end equals contraction.

The behaviour of the castings during cooling is very informative. It is impossible adequately to deal with the results under the conditions imposed. The graphs show that the first six to nine hours cooling is expressed in minutes and thereafter in hours. On examination of the graphs it will be noted that provision has been made for expansion. Below zero line expansion is indicated, and above the line, contraction.

Fig. 6 shows the early cooling behaviour of the simple bar castings. In 12 minutes the 1 in. bar, A, has taken up its maximum expansion at 106 thousandths. Zero is reached in about 23 minutes. At about 43 minutes when contraction equals 560 thousandths, a secondary expansion takes place which lasts for 15 minutes. Afterwards contraction proceeds steadily.

The 2 in. bar B, reaches the maximum expansion of 130 thousandths in 17 minutes, returning to zero in 35 minutes. A secondary expansion is noted after 80 minutes when 540 thousandths contraction had been reached. A further and third expansion is indicated at 145 minutes when 1,125 thousandths contraction had taken place. This expansion remained very steady for 70 minutes.

The 4 in. bar C reached a maximum expansion of 268 thousandths in 50 minutes and reached zero in 117 minutes. A secondary expansion was noted in 180 minutes. This expansion took about 65 minutes to return to the original contraction point. The graph of Fig. 7 expresses in hours the complete behaviour of the three simple bars. It will be noted that the 1 in. bar A has taken up its total contraction of 4,248 thousandths in about 86 hours, which is 248 thousandths more than the theoretical standard. Similarly, the 2 in. bar, B, takes up its total contraction of 4,204 thousandths in about 120 hours. Contraction is 204 thousandths above standard. The 4 in. bar, C, takes 148 hours to reach a final contraction of 4,050 thousandths.

It will be seen that between the thinnest and thickest bar there is a difference of 198 thousandths, confirming the greater contraction of the thinner sections as against the thicker sections when poured separately. The percentage of contraction over standard is as follows:—1 in. bar, 6.25 per cent.; 2-in. bar, 5 per cent.; and 4 in. bar, 1.25 per cent. When it is remembered that the metal is of the moderately close-grained class, the results are also in conformity with the greater contraction of the close-grained iron against the softer variety. Metal of 2 per cent. silicon would correspond more with the standard contraction.

Bedplate

The graph of Fig. 8 expresses in minutes the nine hours cooling behaviour of a bedplate, also 32 ft. in length. The curve D gives the average contraction on the top side of the casting as poured, and curve E the average contraction of the bottom heavy side of the casting carrying the shears or slide-ways. It will be remembered that eight rods are employed to test a bed, four at each corner of the ends—two at the top and two at the bottom at each end.

Several beds tested which carry heavy facings along one side of the casting show a different rate of contraction on each side, both top and bottom, as well as the difference between the top light section and the bottom heavy section. The behaviour of contraction in such cases is expressed by four curves, and reveals some extraordinary stresses and crises during cooling. This Paper would be of too great a length if it included the whole of the tests.

The design of the bed under consideration was uniform sideways; therefore, as revealed by the contraction figures, it was only necessary to produce two curves, one for the bottom contraction and one for the top contraction. The curve D shows that the top area of the bed had expanded 276 thousandths in 30 minutes, and had reached zero in 122 minutes. The bottom heavy area of the bed had expanded 438 thousandths in 35 minutes, and reached zero in 188 minutes.

The graph, Fig. 9, expresses the cooling curves in hours. No clear indication of secondary expansions can be noted. Yet, if the minutes curves be examined, one can detect arrests in the curves which may be caused by expansions. The conflicting pulls in a large bed will undoubtedly mask somewhat expansions, since one part of the bed will be expanding when another area is beginning to contract. In tests on very heavy beds the secondary expansions are almost as clearly defined as on the simple bars previously outlined.

Returning to the graph showing curves in hours, it will be noted that contraction is fairly regular until at 53 hours the contraction on the top and bottom areas of the casting is equal. At this point the curve E—bottom heavy side of the casting—crosses the curve D, from which point the contraction of the bottom E begins to exceed that of the top D. Undoubtedly, it is at this stage that the severe stress and bending begins to function.

The critical period of 53 hours marks the period after which any aids in relieving the casting will be of little use. In the 53 hours, the bedplate has completed nearly 756 of its total contraction. From this point the contraction of the bottom area E steadily increases its lead over that of the top area D. In 190 hours

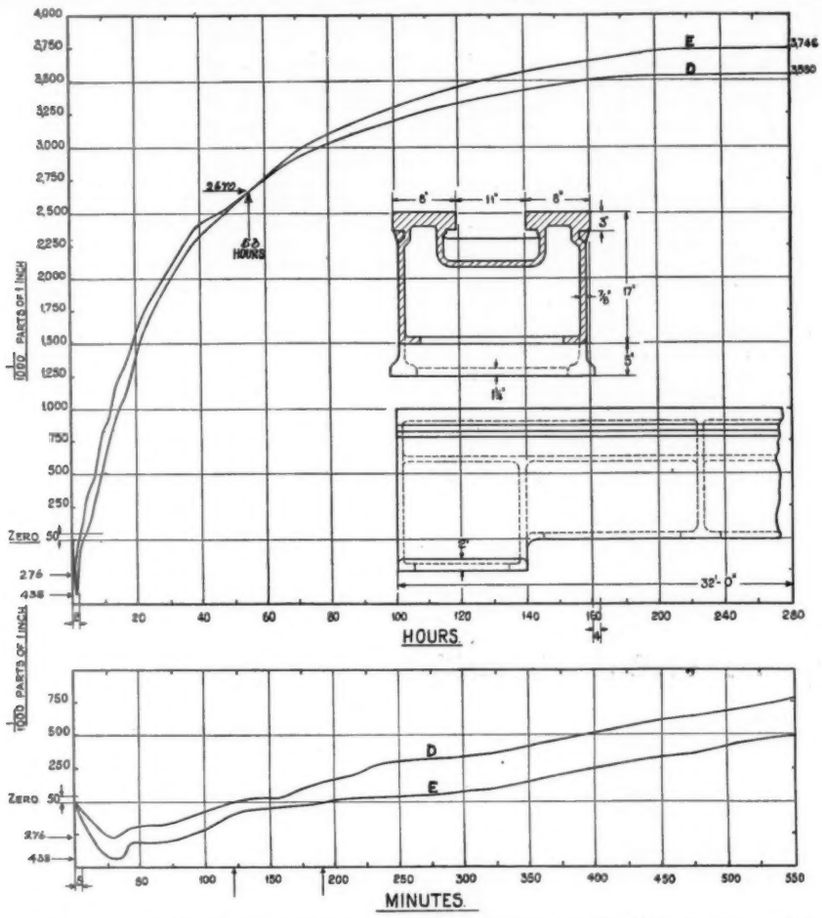


FIG. 8 (LOWER GRAPH).—BEHAVIOUR OF THE UPPER AND LOWER SECTIONS OF A 32-FT. LONG BEDPLATE.

FIG. 9 (UPPER GRAPH).—EXTENDED TIME RECORD WITH THE CROSSING OF THE LINES AFTER TWO DAYS.

the top area had ceased to contract and the bottom in 220 hours.

The total contraction of the top is 3,550 thousandths or 88.86 per cent. of theoretical standard. The total contraction of the bottom is 3,746 or 93.65 per cent. of standard.

Finally, on the total contraction an allowance must be made for the difference in length that a curved line will give when straightened out. The bed on straightening from the camber given will account for approximately 30 thousandths extension of the bed. The amended figures will then read 3,520 for the top area or 88 per cent. of standard, and 3,716 for the bottom area or 93.06 per cent. of standard.

A further amendment is needed in all the curves expressed in the graphs for the extension of the testing rods, due to expansion by heat, and which is included in the total figure of expansion below the zero line. This extension of the rods will slightly affect the times stated in the curves, diminishing and disappearing as final cooling is reached. The final contraction is correctly stated as between the measurements before pouring the casting when everything is cool and after contracting when all is cool.

Tests were made by placing rods of the size as used in the major tests between fixed points on a machined table and setting the inside micrometers to a gap formed at the end of the rod. The difference between the gap with the cold rod and after heating to a similar temperature as obtains in the various sections of casting dealt with gives the number of thousandth parts of one inch to be deducted from the first expansion figures.

The amended figures will approximate to:—

For the 1-in. bar, A, Fig. 6, first expansion, 106 less 30 thousandths equals 76 thousandths net expansion.

For the 2-in. bar, B, first expansion 130 less 45 thousandths equals 85 thousandths net expansion.

For the 4-in. bar, C, first expansion 268 less 120 thousandths equals 148 thousandths net expansion.

Referring to the bedplate the amended figures for the first expansion will approximate to:—

For the top area, D, first expansion 276 less 124 equals 152 thousandths net expansion.

For the bottom area, E, first expansion 438 less 166 equals 272 thousandths net expansion.

Vital Comparisons

	Thousandths.
BEDPLATE—	
Bottom area, E, contraction ..	3,716
Top area, D, contraction	3,520
Extra bottom contraction over top ..	196, or $\frac{1}{5}$ in.
THREE BARS	
1-in. bar A, contraction	4,248
2-in. bar B contraction	4,204
4-in. bar C contraction	4,050
Extra contraction on 2-in. bar over 4-in. bar	154
Extra contraction on 1-in. bar over 4-in. bar	198 or $\frac{1}{5}$ in.

In the bedplate the thick sectioned area contracts more than the thinner sectioned area, which is quite opposite to the contraction on the simple bars where the contraction of the thinner bars exceeds the contraction of the thicker bars.

	Thousandths.
The average contraction of the three bars equals	4,167
The average contraction of the bedplate equals	3,618
The average difference between bars and bed	549

These results show clearly how the contraction of large castings is influenced by design. In bedplates one learns that the conflicting expansions and contractions due to the varying sections length and its relationship to the mould frictional-resistance and the resistance set up by cores cause considerable stress and strain, so much so that the castings do not contract as much as a simple unhindered casting. The difference in contraction between the simple casting and the complicated casting is quite $\frac{1}{2}$ in. It is easy to understand from this why castings distort or even fracture.

Time and Motion Study in the Foundry

By C. D. POLLARD

(*Continued from page* 108.)

Time Study in Progress

To imagine that the investigator from the time and motion study department has a policeman's sort of job is erroneous. This investigator has, by means of the motion study, made an endeavour to help the workman to make moulds off the pattern plant by a series of operations which should be carried out with rhythm and the minimum of expended energy. It is by time study and observation, during actual production, that proof can be obtained as to whether or not the results of the motion study are satisfactory. Of course, it is essential to record the time taken, in order to fix piecework prices.

Specimen Observation Sheet

Fig. 4 shows a specimen of the observation sheets on which the investigator makes a record of the time study. In this case the study on a particular mould commenced at 23 min. 21 sec., the mould being completed at 32 min. 29 sec., and it will be seen that the investigator has accounted for every second of the time between these figures. Each operation is clearly picked out and the actual time taken to complete it is recorded. Even at this stage the operator may be doing some unnecessary work and wasting energy, and should be corrected.

For instance, the pattern plate must be rapped with a mallet on completion of the ramming and before the flask or box is lifted, in order to facilitate an easy draw or lift. Years of experience and innumerable time studies have shown that a certain type of plate requires 12 to 13 sec. total time for this operation, including picking up and putting down the mallet. If that has been proved satisfactory, why waste energy by rapping the plate for a longer period? The time study will result in guidance for the operator in this and other directions.

Further than this, the investigator will take care that there is a convenient spot on which to put the mallet without causing the operator to reach over or bend down in the operation, or find it necessary to make awkward movements which take the rhythm out of the sequence of operations. This is observation No. 4, and on operation No. 27 an abnormal time is recorded. This point should be noted, as it will be referred to in Fig. 5. The total number of operations on this mould is 37.

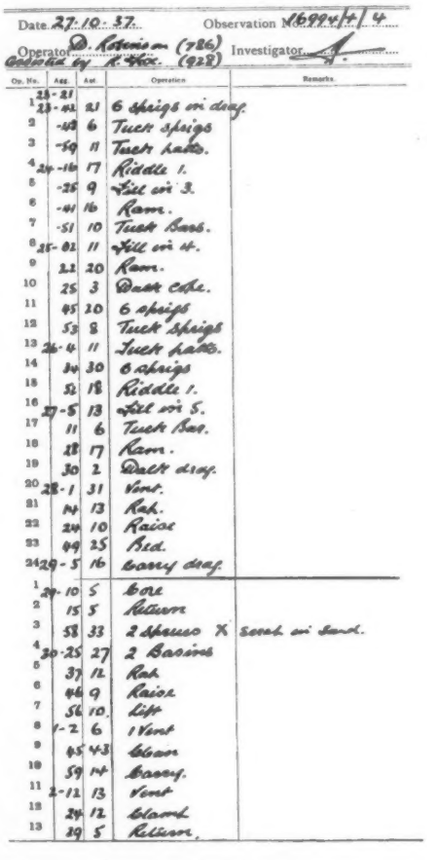
The actual number of observations made for each time study (*i.e.*, the total number of moulds on which time is taken) is at the discretion of the investigator, and depends to a large extent on the nature of the job and on the comparable data in existence. For instance, the whole of the operations on some moulds would be standard for the particular size of moulding boxes in use, and in consequence the investigator would not find it necessary to extend his time study.

On the other hand, there are new jobs on which the operations are not all standard, and the investigator must take time studies over an extended period of production, in order to arrive at a satisfactory time for the non-standard operations. It will be understood that some jobs call for more sand tucking than others, some need more facing sand, and so on. Thus, the standard time allowed for such operations will vary on different types of moulds, despite the fact that the same size of moulding boxes is used.

Whilst the time study is proceeding, the operators carry on in the usual manner of production, and the investigator notes incidental happenings, such as cigarette lighting, talking to workmates, or maybe the removal of pieces of metal scrap from the backing sand, etc., which cause varying times to be recorded against certain operations in succeeding observations.

Analysis Sheet

Fig. 5 shows a specimen analysis sheet, and indicates the method of tabulating the time study figures. On completion of the time study on a job, the figures are copied on this sheet


Date 27:10:37. Observation No. 16994/4/4
Operator D. Robinson (726) Investigator
Checked by F. Fox. (928)

Op. No.	Abs.	Act.	Operation	Remarks
1	23-21	21	6 sprigs on drag.	
2	-43	6	Tuck sprigs	
3	-59	11	Tuck bats.	
4	24-16	17	Riddle 1.	
5	-26	9	Fill on 3.	
6	-41	16	Ram.	
7	-51	10	Tuck Bats.	
8	25-02	11	Fill on 4.	
9	22	20	Ram.	
10	25	3	Dust cope.	
11	45	20	6 sprigs	
12	53	8	Tuck sprigs	
13	26-4	11	Tuck bats.	
14	34	30	6 sprigs	
15	52	18	Riddle 1.	
16	27-5	13	Fill on 5.	
17	11	6	Tuck Bat.	
18	28	17	Ram.	
19	30	2	Dust drag.	
20	28-1	31	Vent.	
21	14	13	Rab.	
22	24	10	Raise	
23	49	25	Bed.	
24	29-5	16	Sandy drag.	
1	29-10	5	Bore	
2	15	5	Return	
3	53	33	2 sprues X	Scrub on sand.
4	30-25	27	2 Basins	
5	37	12	Rab.	
6	46	9	Raise	
7	56	10	Lift	
8	1-2	6	1 Vent	
9	45	43	Clean	
10	59	14	Sandy.	
11	2-12	13	Vent	
12	24	12	Stand.	
13	39	5	Return.	

FIG. 4.—SPECIMEN TIME-STUDY OBSERVATION SHEET.

from the observation sheets, and the actual time against each operation, on each succeeding mould, is shown in columns, with a view to working out the average times taken.

In this case ten moulds have been made on which time study was carried out and are shown as Nos. 1 to 10. As indicated in Fig. 4, there are 37 operations in making up each mould, and these are shown as Nos. 1 to 37. The investigator makes an analysis of the figures and strikes out any abnormal time, where obviously something has happened to break the sequence of production. For instance, there is the rapping of the pattern plate, as already remarked upon. It is apparent that on the first three moulds the rapping of the plate (operations Nos. 21 and 29) took 18 to 20 seconds,

but after a talk on the matter, around 12 seconds were proved to be satisfactory. On mould 5, operation 18 was struck out, as the time taken was abnormal, and on mould 4, operation 27 was also struck out.

Provided all times were considered to be normal and no striking out was necessary, the average would be taken on all ten moulds, but in cases where striking out has occurred, the average is taken on those figures which are left. In this example the average time for operations 18, 21, 27 and 29 is taken on 9, 7, 9 and 7 moulds respectively, and for the remaining 33 operations the average is taken on 10 moulds.

The average times for each operation would then be compared with existing data, and standard times allowed on standard operations, irrespective of the time taken by the operators during the time study. On non-standard operations the average time shown on the analysis sheet is allowed.

In the example given in Fig. 5 there are four non-standard operations on which non-standard times would be allowed, and they are indicated by the numbers in the left-hand column. Such non-standards are logged, filed and indexed, and may eventually become one of thousands of references which make up standards for certain operations.

The essence of this investigation and time study is the determination of how many times in a working day an operator can repeat a certain process (for example, making moulds or cores, or the process of grinding castings, etc.), providing he or she has every facility offered in respect of tools, equipment and materials, and the work is so organised as to prevent unnecessary waste of energy.

When that determination has been made, it is regarded as the possible daily standard of production, but it is appreciated and acknowledged that incidental delays, which interfere with continuous work, must be allowed for in the determination of the accepted standard output. Therefore, an allowance of 10 per cent. is made off the possible standard, which gives the piecework standard, on which the piecework rates are calculated. Thus, if the possible standard is 100 per day, the actual standard on which all calculations are based for piecework prices and bonus would be 90 per day, and 90 per day or more is what is expected from the operator.

Instruction Cards

Piecework rates are now worked out, and the investigator makes out an instruction card, shown in Fig. 6. This is a typical card (or in this case a dual card) covering one man and one boy working on two hand-press moulding machines. As much detail as can be put into writing is shown on these cards.

In the first place, the tools to be supplied to the operators are enumerated, and the type of moulding machine, size of boxes, etc., are shown. Details are also given of the piecework price, the bonus to be paid, total time per box, possible standard, percentage allowances for eventualities, and the daily piecework standards. The whole of the operations which were recorded during the time study, and the standard time for each of those operations, are given, and in the right-hand column is the index number of the reference card which gives the standard for that particular operation.

The operators may at any time ask to see those reference cards; in fact, the investigators are always ready to turn up references and confirm any figures regarding time allowances, in order to satisfy the operators that the piecework prices are based on facts, as they are represented by figures in the files of the time and motion study department.

A copy of the instruction card for any process on which they are working is available for the operators, and they may have one in their possession for guidance and information whilst they are on the job to which a particular card refers.

When repeat orders are received, the sales department usually call for a re-estimate of the job in order to check the price, and later issue to the works the order sheets giving all the details required for the internal booking in the works and offices.

The planning department give consideration to delivery requirements, and in due course the job is scheduled for production. The foundry manager and time and motion study department take note of this, and the latter issue a copy of the instruction card for the job to the foundry foreman, whose duty it is to see that the required tools, etc., are ready for the operators at the time the pattern actually goes into work. This instruction card, by the way, would be the original one prepared when the job first went into work, and is made up from the original time study figures.

The foreman must also satisfy himself that the operators understand the whole of the operations as laid down on the instruction card. As with a new job, so with a repeat order—the operators may at any time retain a copy of the instruction card for the work on which they may be engaged. Thus, the operators make a positive start on any job which comes in as a repeat order, whether they had actually worked on it or not when it had been in work previously.

The variables which usually creep in at the start of work on repeat orders are practically eliminated, as the instruction card and layout sheets give in minute detail all that was done previously and leave no doubt as to what labour, tools and materials are required, and with few exceptions production re-commences where it was left off on the previous order.

FIG. 5.—SPECIMEN ANALYSIS SHEET, SHOWING METHOD OF TABULATING TIME STUDY.

1922 Instruction Card

An example of actual experience is shown in Fig. 7, which is a reproduction of an original instruction card dated September, 1922, which was issued to the foundry a few weeks ago upon receipt of a repeat order. The author had seen neither the pattern plant, instruction card, nor drawing, prior to the job being scheduled for work, but with a copy of this instruction card as a guide, no difficulty in starting up the job was found, and the operator was able to exceed standard production on his first day's work, thus earning a fairly high efficiency bonus.

Fixing of Piecework Rates

Turning now to the fixing of piecework prices and payment of wages, it must be borne in mind that the management's energies should be expended on producing first-class castings at competitive prices. Whatever the system of control, that object will not be achieved unless the operators are satisfied, and the most appealing factor in this direction is to offer every opportunity for them to earn good wages.

Some workers are satisfied with earnings somewhat in keeping with the standard day rate, and show no ambition to earn more, and although their low production may not reach such a point that the overhead charges on the unit being produced are not covered, the minor absorption of the overheads by virtue of low output will have an adverse effect on the profit and loss account. On the other hand, there are workers who will get the maximum production and consequently absorb or over-absorb the estimated overheads. Thus the ideal system of payment is one which makes it necessary for the average workers to maintain a certain output

or suffer a corresponding reduction in earnings, and at the same time increases the opportunities of the faster workers to reap a full reward for their efforts.

A differential system of payment was adopted many years ago, and put into operation for this purpose. In this system of payment the operators are given piecework rates of so much per article or so much per 100 articles, plus a percentage bonus of all earned over a certain sum per hour.

For example, if an operator's basic rate is 1s. per hour, the basic piecework rate is based on that figure plus 33⅓ per cent.; thus the basic piecework rate would be equal to 1s. 4d. per hour, and in such a case an efficiency bonus of, say, 50 per cent. of all earnings over approximately 1s. per hour would be paid. In the fixing of the basic piecework rate, every encouragement is given to the operators by the liberal interpretation of the usual trade agreements which are to the effect "that piecework prices should be fixed to allow operators of average ability to earn day rate plus 25 per cent."

In addition to the liberal interpretation of this by giving a high piecework rate, there is the added incentive of the efficiency bonus, which is paid on earnings exceeding a sum approximately equal to day work.

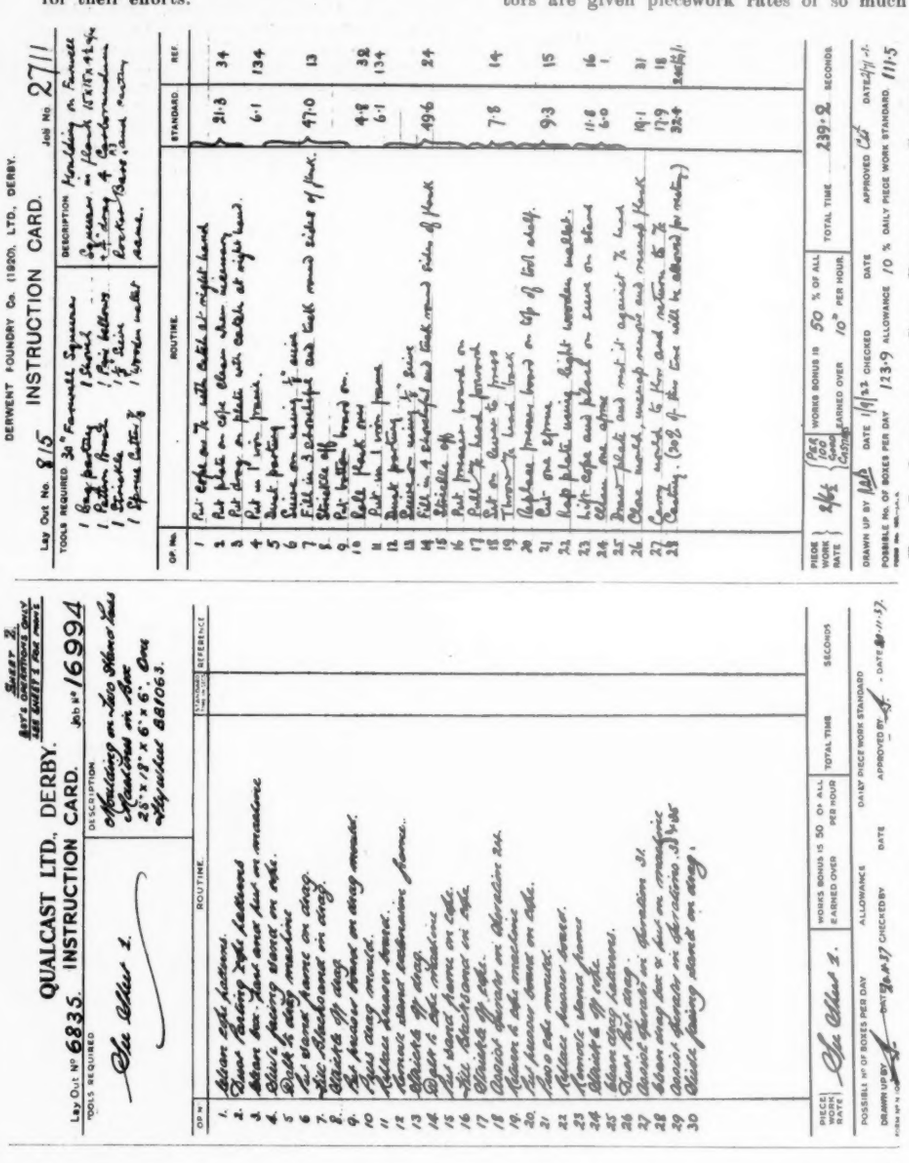


FIG. 7.—INSTRUCTION CARD PREPARED IN SEPTEMBER, 1922, AND RECENTLY USED FOR A REPEAT ORDER.

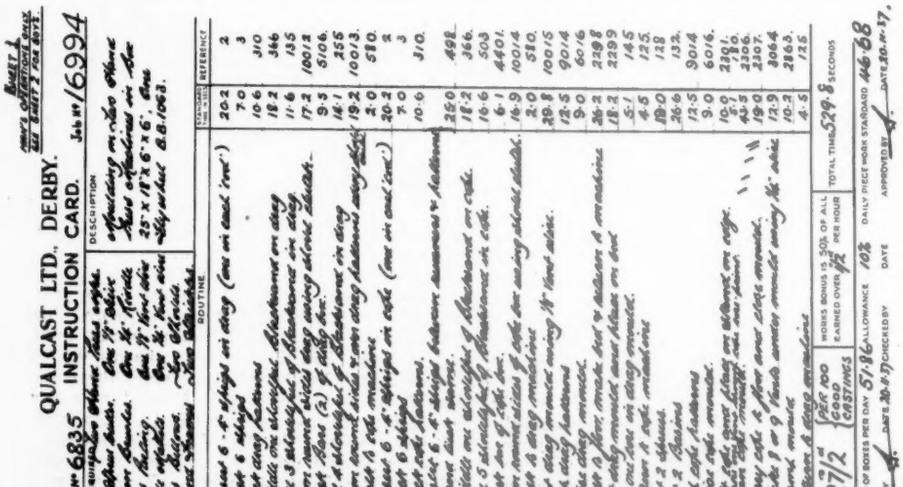


FIG. 6.—DUAL INSTRUCTION CARD COVERING ONE MAN AND A BOY.

Piecework Earnings

Fig. 8 illustrates what is meant by differential payment of wages, and shows by comparison the advantage derived when an operator maintains or exceeds standard output. In these examples 94 castings represent standard output in a week of 47 hours, *i.e.*, one casting per half-hour. The piecework price is based on day rate of 1s. per hour; therefore the piecework price per casting is 8d., equal to 1s. 4d. per hour. From the figures given it is seen that an operator working exactly

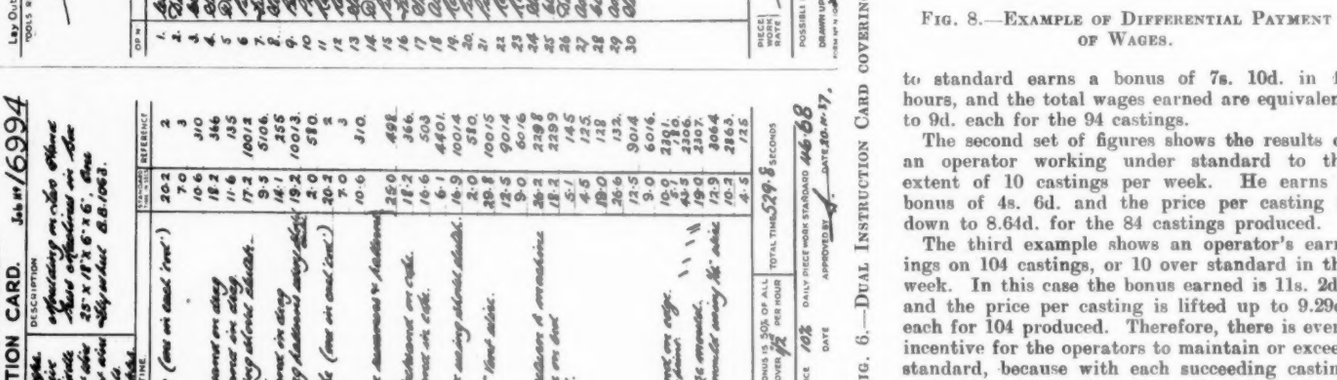

Examples of Operators Earnings
1. Operator on Standard.
94 castings at 8d each £3-2-8
50% of all earned over 1/- per hour 7-10
Total Earnings £3-10-6
2. Operator under Standard.
84 castings at 8d each £2-16-0
50% of earned over 1/- per hour 4-6
Total earnings £3-0-6
3. Operator over Standard.
104 castings at 8d each £3-9-4
50% of all earned over 1/- per hour 11-2
Total Earnings £4-0-6
It will be seen that the Operator producing Standard earns £3-10-6 for 94 castings or 9·00d per each.
The man under Standard makes 84 castings for £3-0-6 or 8·64d per each.
The man over Standard makes 104 castings for £4-0-6 or 9·29d per each.

FIG. 8.—EXAMPLE OF DIFFERENTIAL PAYMENT OF WAGES.

to standard earns a bonus of 7s. 10d. in 47 hours, and the total wages earned are equivalent to 9d. each for the 94 castings.

The second set of figures shows the results of an operator working under standard to the extent of 10 castings per week. He earns a bonus of 4s. 6d. and the price per casting is down to 8.64d. for the 84 castings produced.

The third example shows an operator's earnings on 104 castings, or 10 over standard in the week. In this case the bonus earned is 11s. 2d., and the price per casting is lifted up to 9.29d. each for 104 produced. Therefore, there is every incentive for the operators to maintain or exceed standard, because with each succeeding casting made there is the knowledge that the price is increased on those already made during the current working week.

(To be concluded.)

Scottish Ironworkers' Wages

Wages of workmen employed on basis rates in the pig-iron trade of Scotland will be increased by 7 per cent. The accountants report that the certified returns of the industry for October, November and December last, made by the employers, showed an average net selling price of £5 15s. 9.193d. per ton, which means an increase for the employees.

Australian Foundry Practice with Special Reference to Vitreous Enamelling*

By W. THOMAS

It is with considerable pleasure that we publish Mr. Thomas' Paper on the Australian Foundry Industry, with special reference to the Vitreous Enamelling Trade, as its appearance happily coincides with the 150th anniversary celebrations now being held throughout the Dominion.

It was with considerable hesitation that the author accepted an invitation to read a Paper on the foundry and enamelling trades in Australia, for he is neither a practical foundryman nor a practical enameller, but a chemist whose present business is linked up with those two spheres of activity in the Antipodes. The reason for accepting, however, was because he felt that in his visits to the foundries and plants with which he is connected he may have learnt things that will be of interest to fellow members of the two Institutes.

Geographical Considerations

As the whole of the trade and practice is bound up with the geographical relationship between the large centres of population, it seems desirable first of all to give some idea of the distances between the main centres. To begin with, the distance across Australia is 2,500 miles, and from north to south is 1,950 miles. From Sydney to Brisbane is some 400 miles, Sydney to Melbourne some 500 miles, and from Sydney to Perth about 2,250 miles, so it is obvious that it is a little unkind to ask an agent resident in Sydney why he has not followed up some small order in Perth.

It should be noted that the main centres of industry are in New South Wales, round Sydney and Newcastle, and in Victoria round Melbourne. The other main cities, Brisbane, Adelaide and Perth, have each their manufacturing quarters, but as the population for which they have to cater is comparatively small, a considerable proportion of the wants of these districts is supplied from the Eastern States.

There are, of course, other centres of activity, such as Broken Hill and Iron Knob, in both of which districts large plants for the production of pig-iron are in operation.

Genesis of the Industry

The presence of iron ores in various parts of Australia has been known for a considerable time, but it was not until some twenty years ago that any real progress was made in the smelting and working up of iron. Some ninety years ago a blast furnace and foundry were erected at Mittagong, a few miles along the coast south of Sydney. The company was known as the Fitzroy Mining Company. It is of interest to note that two beam engines were used to supply blast for the blast furnace and cupola. At Mittagong there is a small, but rich, deposit of iron ore, with coal and limestone available nearby.

After a few years of operation the company appears to have become defunct, until in the year 1877 Messrs. Larkin, Hunter & Henshaw took over the works and installed rolling mills; but this venture only lasted till 1878. In 1886 Mr. William Sanford started re-rolling old rails at the mill, and the first attempts were made to produce sheet iron.

While these events were taking place at Mittagong, fresh developments were being made at Lithgow, a small village some fifty miles from Bathurst. A blast furnace was put down in 1875, with a weekly output of 115 tons. However, it could not compete against the low price of imported pig, so the company puddled the iron, and at first sent it to Sydney for rolling, but later put down an 18 in. mill. The company then had working a blast furnace, foundry, six puddling furnaces, one ball furnace, two mill furnaces and a Nasmyth steam hammer, and employed over 200 hands.

For a time the company made progress, and William Sanford transferred his attention to Lithgow from Mittagong and took over this works, and in 1900 the annual production was in the neighbourhood of 7,500 tons. William Sanford carried on till 1907, when the company again struck hard times, and eventually was taken over by the bank. The following year the plant was again put into operation, this time by the firm of G. & C. Hoskins, Limited, and from then onwards the output continued to rise.

When supplies of iron and steel from Europe and America were cut off during the war years production increased tremendously, and in 1919 the firm named the Hoskins Iron & Steel Company, Limited, took over from the original company. Nine years afterwards the company entered into a merger with Dorman, Long & Company, Baldwins and Howard Smith, Limited, of Melbourne and the Australian Iron & Steel Company was born.

The Broken Hill Company

In 1915 the Broken Hill Proprietary Company started their Newcastle works, which were of such a size as seriously to challenge European and American competition. The plant consisted of a 350-ton blast furnace, three 65-ton open-hearth furnaces, a blooming mill and heavy rail mill.

The formation of the original Broken Hill Company is one of the romances of Australian industry and may be of some interest. In 1844 Capt. Matthew Flinders, R.N., and Capt. Charles Sturt explored the Barrier Ranges searching for a legendary inland sea, and Sturt describes in his diary how standing on that "broken hill" and looking out over the planes he came to the conclusion that the sea Poole (a previous explorer) had seen was a mirage. Although disappointed he nevertheless brought specimens of the ore from the hill, which were handed over to the South Australian Government for analysis and lost.

It was not until 1883 that Charles Rasp, a boundary rider from the Mount Gibbs station who did some prospecting in his spare time, took some specimens of this broken hill and staked out a claim for a tin mine. Realising

AN AERIAL VIEW OF THE SYDNEY WORKS OF METTERS, LIMITED.

* A Paper read before a Joint Meeting of the London Sections of the Institutes of British Foundrymen and Vitreous Enamellers, Dr. A. B. Everest presiding.

that he was unable to work this "tin mine" himself he formed a syndicate with the others employed at the station, and each in their own name pegged out claims. Two years later in 1885 it was realised that the so-called tin mines consisted of a huge lead lode heavily impregnated with silver chloride. The first assays gave 800 oz. Ag to the ton and subsequent assays as much as 1,000 ozs. and thus was the Broken Hill Company formed.

In 1919 John Lysaght & Company opened up a rolling mill close to the Broken Hill Company's works at Newcastle and drew their sheet bars from that source. The plant consisted of 8 mills and 4 galvanising units with an output of 40,000 tons of sheets per annum. By 1929 this had grown to 80,000 tons, the increase having necessitated the putting down of a further 8 mills. In 1934 a mechanical mill was brought into service, bringing the output up to 100,000 tons and employing 1,400 men. So it will be seen that in the last twenty years Australia has provided herself with the raw materials required for the founding of sheet steel industries.

Raw Materials for Enamelling

With regard to the raw materials for enamelling, Australia is not so favourably placed, or rather it would probably be more accurate to say that as yet minerals of suitable chemical and physical properties have not been discovered in situations which make the mining of them an economic proposition. Felspar, however, is found in quantity in several districts, but general experience has shown this to vary in composition, which makes it unsuitable for enamelling. Cryolite has not so far been found in any quantities; fluorspar is obtained locally, as also is a reliable grade of quartz, whilst borax has of course to be imported. Tin oxide is now being made from Australian tin in considerable quantities, and the import of this into Australia has practically ceased.

Moulding Sands

Coming now to the question of sands for moulding, until quite recently, when Mr. H. F. Whitworth, B.Sc., of the N.S.W. Department of Mines made a geological survey, the obtaining of suitable moulding sands presented a considerable problem. However, his researches have brought to light several new sources of supply. Almost inexhaustible supplies of clean quartz sand are to be obtained from the wind-blown sand dunes around Sydney, Newcastle and Port Kembla. The beach sands being impregnated with salt and shell grit are of course unsuitable, but where this sand has been carried back by the wind and leached with rain, sands of remarkable purity are found.

Sand-pits at Botany, Alexandria and Kensington supply the main requirements of the Sydney district, and the large dunes north of Lake Illawarra supply the Kembla district. Lithgow has little suitable sand and supplies have to be brought from Sydney.

TABLE I.—*Composition of Australian Silica Sands.*

	Bondi beach sand.	Bondi dune sand.	Botany dune sand.
Moisture ..	—	—	0.03
Silica ..	97.74	98.87	99.2
Iron oxide and alumina	1.0	0.25	0.32
Lime ..	1.26	0.99	0.1
Magnesia ..	Trace	Trace	0.07

These wind-blown sea sands have, as is to be expected, very similar composition and form. The grains are evenly rounded and of equal size, with very small amounts of shell grit, mica and felspar as impurities.

The following analyses (Table I), taken from the N.S.W. Geological Survey Bulletin No. 15, show the variation in dune sand and beach sand.

Table I shows the results of the leaching process, and the Botany sand is more typical of the grass-covered dune sands than the Bondi sands.

The grain size of Bondi sand is as follows:—

	Per cent.
Sand left on 30-mesh sieve	0.2
" " 60- " "	50.5
" " 90- " "	49.1
" passed 90- " "	0.2
	100.0

From the open nature and the regular rounded form of this sand, a very high permeability is obtained, figures from 400 to 600 being common, with the optimum moisture content of about 2.5.

Previous to the use of these dune sands, river sand was used, and the following comparison is interesting:—

	River.	Dune.
Sand left on 30-mesh sieve ..	28.7	0.2
" " 60- " " ..	52.9	50.5
" " 90- " " ..	14.2	49.1
" passed 90- " " ..	4.2	0.2

Large deposits of this river sand are found along the Hunter River, near Morpeth, and coarser sands on the Nepean River, between Penrith and Windsor.

TABLE II.—*Composition of Australian Sandstones.*

	1	2	3	4	5	6	7	8
SiO_2	79.66	79.28	91.44	82.05	88.85	86.75	86.89	78.75
Al_2O_3	9.43	7.96	4.41	9.20	6.01	6.12	9.90	10.93
Fe_2O_3	0.10	1.40	0.50	0.50	0.10	0.30	0.30	0.10
FeO	3.00	2.88	0.18	1.92	1.37	1.92	2.07	2.48
CaO	0.64	0.32	0.34	0.22	0.08	0.20	0.11	0.16
MgO	0.56	0.41	0.18	0.39	0.25	0.36	0.15	0.52
K_2O	2.16	2.39	0.60	1.50	0.81	1.14	1.45	1.58
Na_2O	0.23	0.62	0.04	0.16	0.01	0.15	0.18	0.21
H_2O — 100 deg. C.	0.60	2.46	0.25	0.68	0.33	0.40	2.56	0.94
H_2O + 100 deg. C.	1.52		1.57	1.80	1.05	0.98		2.50
TiO_2	0.45	0.52	0.52	0.35	0.66	0.69	0.05	0.51
CO_2	1.94	1.97	—	1.34	0.84	1.29	1.14	1.61

No. 1 Hawkesbury sandstone from Cosford Freestone Quarry.
" 2 " " " Stuart's Quarry, North Bondi.
" 3 " " " Botany Brickworks Quarry.
" 4 " " " Saunder's Quarry, Pyrmont.
" 5 " " " Purgatory Quarry, Pyrmont.
" 6 " " " Ryan's Quarry, Waverly.
" 7 " " " Undercliff.
" 8 " " " Annandale.

Note.—The high alkali content of 1, 2, 4, 7 and 8 render them unsuitable for moulding sands.

The soft carboniferous sandstones of Scotland known as Rotten Rock, and used for a base for steel moulding sands, have their duplicates in Eastern N.S.W. These sandstones vary very considerably, as Table II clearly shows.

Loam

Deposits of loam occur in the Hawkesbury area (north of Sydney). These loams appear to be the relics of flood-planes, and occur usually on the top of what are now hills, though which were at one time depressions in a plateau. These small areas of loam, which are only about 4 ft. deep and an acre in extent, are large in number, and in some cases can be used direct as natural moulding sands. In most cases, however, they must be opened up with dune sand. Each deposit shows different characteristics, and is usually sandy on the top and more clayey as it goes down.

Layers of loam, some of which are worked for foundry purposes, occur capping hills of the Upper Coal Measures to the south of Newcastle, in the vicinity of Dudley, Cardiff, Whitebridge and Redhead. The Sydney district obtains its supply of loam from the deposits situated on the flood terrace of Cook's River, near Canterbury.

Table III shows an analysis of Canterbury loam.

The bond strength of this loam is high, reaching a maximum of 4.6 lbs. per sq. in. at a moisture content of 8.5 per cent. With the same moisture figure the permeability is about 60.

Clays

Clays are found in the districts under review for loam, some of the best coming from East Maitland. The addition of a small amount of this clay imparts great strength to a sand without seriously lowering either permeability or melting point of the mixture.

TABLE III.—*Chemical and Physical Composition of Canterbury Loams.*

Silica	86.40
Alumina	8.37
Iron oxide	1.83
Lime	Trace
Magnesia	0.01
Alkalies	Trace
Moisture and combined water	3.40
Total	100.01

Sand left on 30-mesh sieve	2.8
" " 60- " "	44.1
" " 90- " "	12.0
" passed 90- " "	13.4
Clay substance	27.7

It will be noticed that only the N.S.W. sands have been reviewed, as these have been subject to survey. The author is not aware if the sands used in Victoria, South Australia and Western Australia have been subject to a similar investigation. He can, however, give figures for the analysis of an alleged moulding sand that the Melbourne Works of Metters, Limited, had to put up with some little time ago:—

Clay	7.5
Silt — 300 mesh	7.1
Coarse silt + 300	5.7
Fine sand + 150	15.4
Medium sand + 60	30.1
Coarse sand + 30	21.0
Very coarse sand + 16	11.0
Gravel + 8	2.2
Moisture	5 per cent.
Permeability	70 "
Green compression strength ..	6.4 lb. per sq. in.
Dry compression	23 " "

Owing to the subject of labour conditions being of such an involved nature, when discussing general conditions throughout Australia, it will only be possible to survey briefly the situation covering foundries and enamelling plants in the three main manufacturing States, viz., New South Wales, Victoria and South Australia.

Skilled and Semi-Skilled Foundry Workers

In New South Wales, moulders and all foundry workers are covered by a Federal award, known as "The Metal Trades Award." The wages are based on the ruling "Federal basic wage," plus a margin for skill and plus a loading of 5s., if employed on what is known there as "hourly hiring." This 5s. loading is paid in lieu of payment for all public holidays and an allowance of four days' sick leave in any one

year. The alternative hiring is what is known as "weekly hiring." This engagement entitles an employee to be paid for all public holidays (there are many more public holidays in Australia than here) and four days' sick leave per year. Employment on weekly hiring can only be terminated by a week's notice given by either party, excepting, of course, when an employee commits any misdemeanour, in which case he may be dismissed at a minute's notice.

Margins for skill in the moulding section are classified in two sections—"jobbing and loose pattern work," and "plate and machine." The "jobbing and loose pattern work" has the highest margin, viz., 30s. per week. "Plate and machine moulding" is based on a graduated scale, according to experience, such as:—

	s.	d.	
1st six months' experience ..	9	0	per week.
2nd " " ..	12	0	"
3rd " " ..	15	0	"
After two years' " ..	20	0	"

In the case of the plate and machine moulders, it is only recently that the margins have been set to a sliding scale. Heretofore, only one margin for skill was provided, irrespective of the experience of the employee. In assessing, say, a jobbing moulder's wage, the following method is adopted:—

	£	s.	d.
Ruling Federal basic wage	3	18	0
Margin for skill	1	10	0
Loading for hourly hiring	0	5	0
	£5	13	0

Juniors may not be employed or taught jobbing moulding, except as a trainee apprentice or indentured apprentice. A restriction is also placed regarding the number of apprentices to tradesmen and no more than the prescribed proportion may be employed.

In the "plate and machine moulding" section, juniors may be employed without any restriction, on account of this work being classed as semi-skilled, and for which no apprenticeship is provided.

General Foundry Labour

Dressers, fitters and grinders, cupola furnacemen and foundry labourers are covered by the same award as the moulders, but under a different section, viz., the "ironworking section." Margins for skill are set for these employees in the same way as the moulders, excepting that no sliding scale is adopted for industrial experience. The method of assessing the wage is the same as the moulders, taking the ruling basic wage, plus the margin for skill, plus the loading if employed on hourly hiring.

A Variation

In Victoria, the principle is somewhat different, in that the moulders are covered by the same general award as New South Wales, and the same restrictions apply to the employment of juniors other than apprentices, but when it comes to other sections of foundry workers the position changes. The employees are covered by a "State award," *i.e.*, an award which only applies to the State of Victoria. In effect, one finds employees working alongside one another and both being paid under different conditions; by that is meant that the "basic wage" alters, although the cost of living is the same for both sections.

South Australia is different from both New South Wales and Victoria in all respects, as employees are all employed under "State awards." These awards are assessed by what are known as "Wage Determination Boards"—an equal number representing both employers and employees. The wages paid in South Australia are far below those paid either in New South Wales or Victoria.

In analysing the above remarks, it will be noticed that the three States, all making identical articles, are all paying different wages, and thereby setting up very severe interstate competition, which sometimes results in very pertinent questions being asked in the Federal Parliament. However, it is the aim of the Commonwealth Court of Conciliation and Arbitration ultimately to end this severe overlapping of awards.

TAPPING BALANCED-BLAST CUPOLA OF 57 IN. DIA.

THE PATTERNSHOP OF METTERS, LIMITED.

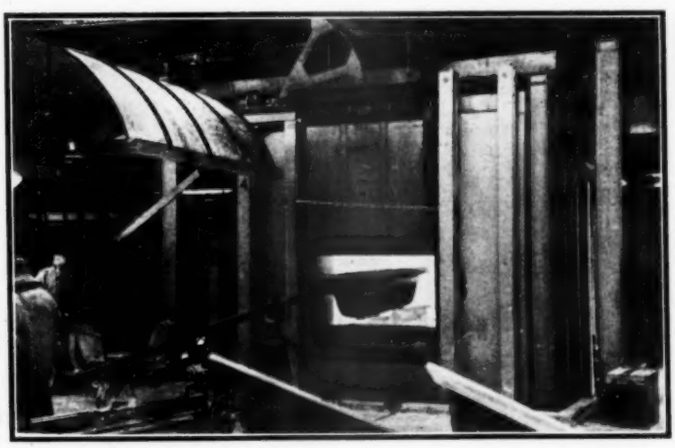
Porcelain Enamelling

This work is known here as two distinct processes:—"Dry," which covers the enamelling of articles such as baths, sinks and sanitary-ware, etc., by the dusting method; and the "wet" process, which covers the enamelling of sheet iron, signs and hollow-ware, and light castings, such as stove parts, etc.

In New South Wales, both processes are covered by the "metal trades award," and the same method of assessing wages is adopted. The enamelling of baths is usually done by a squad of three men—a duster and two assistants. The dusters, being the main factor, get a margin for skill of £2 10s. and the assistants 30s. each.

In Metters Works, which houses the largest enamelling plant in Australia, the bath enamellers are on a piecework basis, set at a price per

A SECTION OF THE FOUNDRY MAKING STOVE PARTS.



BATH ENAMELLING FURNACE.

bath. This price is so set as to enable the average competent man to earn at least 10 per cent. above his time work wage.

No juniors or females are allowed to work in the dry process, owing to the supposed hazardous nature of the work. At the Sydney works of this company, a monthly examination of all employees engaged in the dry process is made by a doctor to ensure that the employees are not being affected by the process.

In Victoria and South Australia, there is no award governing this class of employee. Victorian employees are generally members of the Foundry Employees Union, which negotiates with the employer regarding the rate of wages to be paid; consequently, the wages are far below those paid in New South Wales; in fact, there is as great a difference as 20 per cent.

South Australia does very little dry process work; therefore, as mentioned previously, no award governs the employees. The procedure there is to adopt the same method as Victoria, *i.e.*, direct negotiation between employer and employee.

Wet Process Enamellers

Referring to the wet process, the position alters again. New South Wales is governed by the "metal trades award," Victoria by a "federal award" also, but different in its incidence, which is known as the "agricultural implement makers' award." The margins for skill for adult workers are the same in both awards, but the position alters in the case of juniors—both male and female. New South Wales has to pay all juniors on an age basis, *i.e.*, a different rate of wages for every birthday, whereas in Victoria the award prescribes payment for juniors on an experience basis irrespective of age, providing he or she is not an adult (21 years of age). It will be seen that New South Wales is at a decided disadvantage regarding junior employees, considering that 75 per cent. of the total labour employed in the wet process are junior males and females.

South Australia is different from both the other States, in that a State award governs the process, and the margins for adult workers are lower than that of both New South Wales and Victoria. The rate for juniors is based on the experience basis, but is lower than in Victoria.

As the remarks have been confined to foundries and porcelain enamelling only, it is hoped the above brief survey has been sufficiently clear to convey an idea of the conditions regarding the employment of labour in the three States of this country, and to show that in all industries the same anomalies are present.

This brief survey will be supplemented with a few short remarks regarding basis wage, federal and State; trade unions, and unemployment relief tax as applied to New South Wales only; also the federal basic wage as at present in operation in all States of Australia.

Basic Wage—Federal

This basic wage, which affects approximately 350,000 workers in New South Wales, was arrived at by full inquiry of the Full Commonwealth Arbitration Court—a chief judge and two other judges—and such wage was declared to be the minimum amount to sustain man, wife and two children in reasonable comfort. This wage is subject to alteration every quarter, should the cost of living rise or fall. The rise and fall is ascertained by the Commonwealth statistician, and no alteration is made unless the variation be at least 1s.

Basis Wage—State

The method here is somewhat different from that of the Federal authorities. This wage is declared by the Industrial Commission of New South Wales, which is comprised of a chairman and two members—all judges. The basis is man, wife and one child, and is subject to alteration once in every six months. Although there is a difference in the number of children, Federal against State, the State authorities provide an endowment scheme for the other child. The "basis wage" for adult females is based as 54 per cent. of the male adult rate.

Trade Unions

The trade union movement in New South Wales is stronger than in any other part of Australia. This is probably on account of the State being the backbone of secondary industries in Australia and having the biggest population. Some of these unions have fine buildings for offices and have paid administrative officers at very high salaries. The largest craft unions are those that are concerned with the metal trades industry, such as the Federated Metal Moulders' Union, which has a membership of about 6,000 in all States; the Amalgamated Engineering Union, which incidentally has a very fine granite building of its own; and the Federated Ironworkers' Union and Stovemakers' Union of Australia, whose combined membership runs into many thousands

During 1937 the Metal Trades Unions were in direct conflict with the employers regarding higher wages in view of the increasing prosperity in this State and, ignoring the Court, resorted to direct action to gain their ends. These actions have caused quite a dislocation to industry generally. However, a new general Federal Award is mooted for May, 1938, and possibly all troubles will be rectified and employers will be able to settle down to a little industrial peace.

Unemployment Relief Tax

Every employer in New South Wales must deduct from all employees earning £2 or over an amount as prescribed for this purpose, and such amounts as deducted are paid into the Department of Taxation, which, in turn, forwards the moneys on to the Treasury.

This tax was first introduced during the late depression for the purpose of providing sustenance to all unemployed workers. During the years the tax has been in operation, the amounts to be deducted from wages have varied considerably, and at present the Government is considering altering the whole area and incidence of the tax to a sliding scale according to the dependants a worker may have. As an example, the following are some of the deductions:—

	s.	d.
£2 to £2 10s.	0	6
£2 10s. 1d to £3	0	9
£3 0s. 1d. to £3 10s.	1	3
£3 10s. 1d. to £3 12s. 5d.	1	6
£3 12s. 6d. to £3 14s. 11d.	1	7
£3 15s. to £3 17s. 5d.	1	8
£3 17s. 6d. to £3 19s. 11d.	1	9
£4 to £4 1s. 11d.	1	11
£4 2s. to £4 3s. 11d.	2	0
£4 4s. to £4 5s. 11d.	2	2
£4 6s. to £4 7s. 11d.	2	3
£4 8s. to £4 9s. 11d.	2	5
£4 10s. to £4 11s. 11d.	2	6

The following are the "Federal basic wage" rates operating in the various States (capital cities only):—Sydney, £3 18s. per week; Melbourne, £3 18s.; Brisbane, £3 15s.; and Adelaide, £3 15s.

When discussing foundry and enamelling practice it will be appreciated that the author has to draw on the experience of the factories with which he is associated. These can be safely taken as being representative of the more progressive foundries in Australia.

Melting Practice

On page 121 is a general view of the Sydney works. The goods manufactured cover a large field ranging from cast-iron porcelain-enamelled baths to gas, electric and solid-fuel-fired stoves and water heaters. There are also large departments engaged in stamping porcelain enamelled hollow-ware, aluminium hollow-ware, stainless steel ware, and porcelain-enamelled sheet and sign work.

Starting at the foundry, which covers an area of 14,250 sq. yds., there are four cupolas, two being the balanced-blast type and of 57 in. dia. From one of these has been obtained an output of 67 tons 4 cwts. in a running time of 4 hrs.

SPRAYING BOOTHS FOR CAST-IRON COMPONENTS.

(RIGHT.) GENERAL HOLLOW-WARE READY FOR ENAMELLING. IN THE BACKGROUND ARE THE DRYING ROOM AND THE LABORATORY.

40 mins. The coke ratio including bed was 9.2 to 1 or 10.8 per cent., and excluding bed 10.2 to 1 or 9.7 per cent. The metal was run at an average of 14.4 tons per hr.

The analysis of the coke was:—Fixed carbon, 81.6; ash, 15.4; volatile matter, 1.5, and moisture, 1.5 per cent. The price of such coke was 38s. per ton.

The temperature of the metal varied from 1,416 deg. C. up to 1,429 deg. C., and then dropped to 1,394 deg. C. at the end of the blow. Over the whole blow the temperature varied by only 40 deg. C.

A typical analysis of the iron used is shown in Table IV.

TABLE IV.—*Composition of Cupola-Melted Metal.* Analysis of three test-bars.

	T.C.	Si.	Mn.	S.	P.
1 p.m.	3.2	2.4	0.46	0.05	0.84
2.30 p.m.	3.4	2.5	0.57	0.05	0.81
4 p.m.	3.4	2.5	0.56	0.05	0.78
On another day:—					
1 p.m.	3.2	2.5	0.30	0.05	0.84
2.30 p.m.	3.5	2.6	0.37	0.05	0.78
4 p.m.	3.5	2.6	0.56	0.05	0.78

The cupola charge is usually made up as follows:—50 per cent. pig-iron; 33 per cent. shop scrap, and 17 per cent. outside scrap.

Bath Making

Coming now to the bath floor, here machine moulding is used, the machines being Sandslingers, which were obtained from America in 1924. Altogether there are now seven of the 11 ft. tractor-type Sandslingers in use. Each machine is producing 40 bath moulds per shift of eight hours with five men, exclusive of those employed in casting. These machines are also used for ramming sinks, six in a box. Boxes and metal are handled by six 3-ton and one 4-ton overhead electric travelling cranes.

One Sandslinger is kept busy on pipes, and in this section the boxes are handled by four 10 cwt. air hoists.

Stove Grates

The stove grate moulding section is equipped with 56 pneumatic moulding machines handling boxes varying in size from 27 by 16 in. to 30 by 24 in. Metal is brought from the cupola in bogies.

A very close check on the sand is kept throughout, and thereby the management has been able to produce a respectable sand from the various sands available now.

Mr. H. Cowan, in a recent lecture to the Institute of Vitreous Enamellers (see page 126), gave some representative analyses of British and American cast iron for enamelling, and the comparison with Australian iron is interesting and is set out in Table V.

TABLE V.—*Typical Compositions of Irons Suitable for Enamelling.*

	United Kingdom.	American.	Australian.
T.C., per cent.	3.5/3.7	3.4	3.2/3.5
Si " "	2.5/3.0	2.5	2.4/2.6
Mn " "	0.3/0.5	0.6	0.3/0.57
S " "	0.06/0.09	0.08	0.05
P " "	1.4/1.8	0.7	0.78/0.84

Cleaning Operations

The bath-scouring dressing shop covers some 4,000 sq. ft. and is equipped with twenty-two portable electric grinders. Smaller castings, such as stove parts, are rough cleaned in twenty-four rumblers, each fitted with dust-extraction devices. All castings are, of course, sand-blasted before enamelling.

The sand-blast equipment consists of five independent rooms, each 11 ft. by 12 ft. 6 in., with dust arrestors, screw conveyors and elevators, and one rotary machine for handling small stove parts. Chilled-iron grit is used as an abrasive.

The supply of compressed air for working these sand-blasts and the pneumatic hand grinders, moulding machines, vibrators and air hoists throughout the works is obtained from three large Ingersoll Rand compressors, totalling 500 h.p. and feeding a reservoir 30 ft. long by 6 ft. dia. at 100 lbs. per sq. in.

The water-cooling system has a large reserve tank and a special cooling tower on the roof of the compressor house. This is necessary on account of the shade temperature running up over the hundred mark at intervals during the summer months. It is quite common for the temperature around the muffles to rise to 120, 125 or 130 deg. in the summer.

Enamelling Equipment

Turning now to the enamelling equipment, as mentioned previously, the following types of enamelling are done:—Bath and sanitary-ware, low-temperature liquids for stove parts, stamped hollow-ware, sheet for stove plates and sign work. These departments are as far as possible made self-contained.

The muffles in the cast-iron sanitary-ware section are housed in a shop 250 ft. long. There are four oil-fired carborundum furnaces, one solid-fuel muffle, one four-burner semi-muffle and two carborundum radiant furnaces. The shop is fitted with an efficient ventilating system capable of completely changing the air every five minutes with scrubbed air.

The furnaces and plant are capable of turning out over 600 baths, 250 combination sinks, together with 1,000 pieces of assorted sanitary-ware comprising pedestal basins, wash tubs and sinks per week of five days. The works close down on Saturdays, and four shifts of six hours each are worked per muffle, each shift producing eighteen plain baths.

Frit Making

The dusting-on enamels used are mostly manufactured in the plant. There are several oil-fired fritting furnaces housed in a large semi-air-conditioned melting shop, and ten ball mills and a rotary dryer in the mill room. (By semi-air-conditioned melting shop is meant that all the air entering is scrubbed in order to ensure that no dust comes in from outside. The standard with regard to the absence of black specks in white enamel on cast iron is very high indeed, and it is very difficult to maintain that standard.) The mill sizes are four 2,000 lbs., two 1,000 lbs., three 500 lbs., and one 50 lbs. The foregoing equipment is for the cast-iron sanitary-ware only.

Cooker Equipment

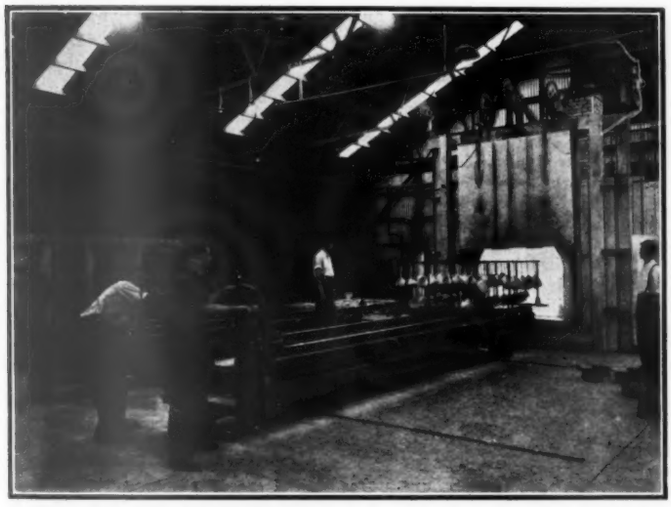
The liquid process of porcelain enamelling was first used in 1924, in which year Metters produced their first all-enamel cooker. At the present time practically all stoves, including electric, gas, and solid-fuel cooking stoves and solid-fuel heating stoves are porcelain enamelled. This section comprises a shop over 100 ft. long, containing three oil-fired muffles and fourteen modern spraying booths, each fitted with two guns, one spray and one mottle.

The mill room for this department contains six grinding mills, two of 400 lbs., one 300, one 250 and one 150, together with some small experimental mills.

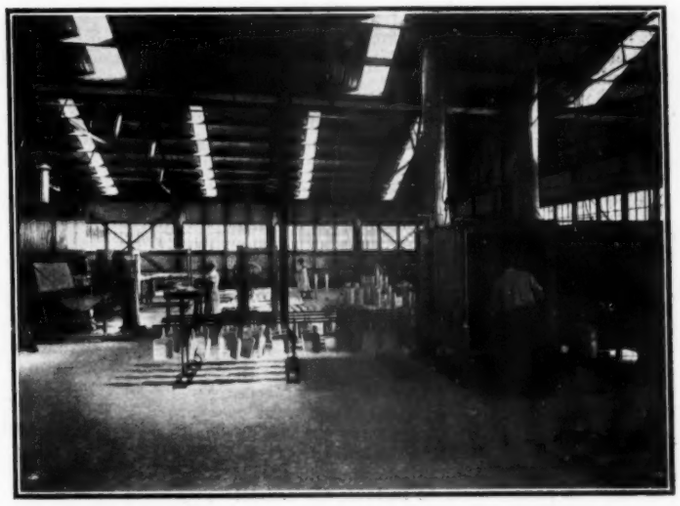
Leadless enamel is used throughout this shop. This equipment is capable of turning out 15,000 stove and other light castings per week in various colours. The latest and greatest demand is for a coloured mottled enamel finish, *i.e.*, a coloured base with white spots.

Sheet Enamelling

The sheet iron and enamelling department covers an area of 50,000 sq. ft., wherein is manufactured stove parts, signs and kitchen utensils. During the past two years this department has undergone many changes and has been completely reorganised. A continuous dryer has been in-



HOLLOW-WARE ENAMELLING FURNACE.



SWILLING PIE DISHES, SPRAYING SHEET IRON AND BRUSHING BATH HEATERS AND FLUE PIPES.

stalled for hollow-ware. This dryer is heated by steam-heated air and has an oil-fired combustion chamber running its full length. It is 49 ft. long, 8 ft. 6 in. high, and 10 ft. wide, and is of the open-end type with air seals on either end. The furnaces, seven in all, are of the muffle box type: two are 9 ft. by 5 ft., four 12 ft. by 5 ft., and one 12 ft. by 6 ft. These are oil-fired with locally-made burners. New furnace tooling made of high-grade heat-resisting steel has been added, thus bringing the furnaces to a position where they are well able to take care of the increased production of the past eighteen months.

Spraying equipment has been added to in the form of the latest type guns, spray booths and air conditioners. The Scott silk-screen process for sign work is still being used, although at the present time the photographic process on to metal screens is being developed.

Pickling Department

The pickling department has been rebuilt, and all stove parts and kitchen ware are packed in Monel crates. These crates are lifted by a Yale electric hoist running on a mono-rail directly above the tanks and placed on a roller runway into a steam-heated dryer. Crates are unloaded on a platform at the other end of the dryer and empty crates continue down a gravity runway to be reloaded. The tanks are made up of two cleaner, two hot rinse, two acid (sulphuric), one nickel, two rinse, and two neutralisers.

The millroom is equipped with two 1,000-lb. mills, four 200-lb. mills, two 50-lb. mills and two 12½-lb. jar mills. All enamels are put through a magnetic separator and roto spray. The smelting room consists of two smelters taking a charge of 1,200 lbs. each. These are charged from the floor above, where all the enamels are mixed. Two smelters of 100 lbs. capacity are used for experimental purposes.

There are 70 female and 160 male employees in the sheet enamelling department. The plant is capable of a weekly production of 40,000 pieces of kitchen ware and 30,000 sq. ft. of stove plates and signs.

The foregoing will have given some little idea of the progress that has been made and the manner in which a branch of the foundry and enamelling industry is carried on in Australia. The firm in question has also another works of about a quarter the size in Melbourne, where a similar range of goods is made. At the Melbourne factory the temperature of the muffle is kept constant by means of a thermostatic device. There is pyrometer control by a chart, and time control by a bell. All the controls are situated centrally, at a point distant from the mouth of the muffle, and the whole apparatus is controlled electrically from that central point or bridge.

The firm also has factories in Adelaide and Perth, though these are more restricted to lines specially suited to the particular State, the more general lines being imported from the Eastern States. A new porcelain enamelling factory has been erected in Perth.

Acknowledgments

In conclusion, the author would like to make the following acknowledgments:—The Broken Hill Proprietary Company; G. & C. Hoskins, Limited, and the Australian Iron & Steel Company, for photographs from which the slides were made, and for historical notes compiled. To Mr. H. F. Witworth and "National Handbook of Australia's Industries" for the Paper on moulding sands in N.S.W. To Mr. R. A. Spring for his great help and interest, and to Mr. Begg and Mr. Fred Spring for detailed and general information regarding the working of foundry and enamel shops, and to Mr. A. Gardner, of Melbourne. To Mr. D. Wallis for the information on wages and working conditions, whose information was quoted *in toto*, and finally to the Australian High Commissioner's Office in London for the loan of certain slides and access to various statistical information.

The Analysis of Cast Iron Suitable for Vitreous Enamelling

During the winter session of the Institute of Vitreous Enamellers, several of the local sections were favoured by a lecture from Mr. H. Cowan, B.Sc., the director of the Scottish Laboratories of the British Cast Iron Research Association, on the subject of the composition of cast iron suitable for enamelling. The text printed below is a report of the lecture as given to the London Section meeting, over which Mr. V. C. Faulkner presided.

MR. COWAN introduced his subject by asking his audience to put aside for the time being all their preconceived notions on enamelling in relation to cast iron, and to consider the problem of the analysis of cast iron from a layman's point of view, *i.e.*, neither a foundryman's nor an enameller's point of view, but that of the true layman. The subject was "Analysis of Cast Iron Suitable for Vitreous Enamelling," and it would, of course, be possible for him to give hundreds of analyses of cast iron varying appreciably as regards their content of carbon, manganese, silicon, sulphur and phosphorus, every one of which would, in his view, be quite suitable for enamelling. However, if any of those present had been thinking that they were to hear of some particular analysis for enamelling, he was afraid they would be disappointed. The position was that any analysis that might be put down on paper would be suitable for enamelling, provided that analysis was capable of producing sound grey light castings.

Influence of Sulphur

The important point to consider was what could possibly happen between the enamel and the various constituents in a cast iron. He would deal only with carbon, manganese, silicon, sulphur and phosphorus, and would not concern himself with the latest American ideas of adding nickel to cast iron. Perhaps it would be as well to start with sulphur, which was an old bugbear in regard to enamelling. Various analyses had been given for cast iron in which the sulphur varied from 0.01 to 0.15 per cent., and as a matter of fact, all of them were quite suitable as regards enamelling.

The question was often asked, "Does sulphur react with any of the oxide constituents of the enamel?" He could answer that, to his knowledge, it did not, within the limits he had mentioned. The reason why the founder did not put an excess of sulphur into his castings was not because he wanted to help the enameller, but because an excess of sulphur was more likely to interfere with himself as a maker of good, clean, grey castings.

Phosphorus Content

With regard to phosphorus, a recent specification drawn up by the American Institute of Porcelain Enamellers gave a figure of 0.7 per cent., and this was given not because it was an ideal phosphorus content in cast iron, but because the blast furnaces did not produce any pig-iron in America with a phosphorus content greater than that amount. What he liked about the American people and some of the Continental people was that when they submitted an analysis they gave reasons for it, and he wished that people in this country would always give reasons in the same way. In the course of his experience he had examined a large number of castings for enamelling, with almost every conceivable analysis. He knew of castings containing from 0.2 up to 1 per cent. of manganese; from 0.06 to 0.15 per cent. sulphur; from 0.7 to about 2 per cent. phosphorus and from 1.8 to 3.5 per cent. silicon, and every one of the foundries making castings to these various analyses made very good castings for enamelling and also very bad ones.

If, therefore, he was asked what was the ideal analysis of a cast iron suitable for enamelling, his answer would be that there was not one. It was all a question of getting a good, clean, grey cast iron, and if he had his way he would make that a sort of text to be put up in every enamelling shop. There was, of course, a friendly rivalry between the enameller and the cast-iron department, but he would endeavour to show before he had concluded his lecture that in his view the founder was on the more solid ground.

Manganese

With regard to manganese, Dr. Norbury had stated, from experimental evidence, that the relationship between manganese and sulphur should be that the manganese should be 1.7 times a sulphur content plus 0.3. Personally, he did not know of any formula showing the relationship of sulphur and manganese which closely approximated to the ideal for manganese: sulphur combination. The main point he wished to emphasise, however, was that if the sulphur exceeded a certain figure, it was not only bad for the casting as a light casting, but it was also bad for the enameller. As a result, however, of years of experience, he was convinced that Dr. Norbury's relationship was one worth noting.

Returning to phosphorus, Mr. Cowan said that the average phosphorus content in Scottish light cast iron was 1.5 per cent. He had seen it higher and lower, and some foundrymen in both England and Scotland had at times expressed a preference for a phosphorus content of 1 per cent., not because 1.5 per cent. was wrong, but because 1 per cent. happened to agree with their enamel. Nevertheless, it did not follow that 1.5 per cent. phosphorus material was not capable of being enamelled. Recently there had been a misfortune in the ironfounding industry in Scotland because there had been a considerable lack of supplies of pig-iron. Nevertheless, although some of the castings in Scotland during the past six months had had what might be called an abnormal analysis, there had been no abnormality in the quality of the enamelling. In other words, those castings were good for enamelling, notwithstanding that the supplies of raw material were limited and the founder had had to take what he could get in the way of pig-iron. In these circumstances it was not unreasonable to insist that analysis was not a criterion of the quality of the enamelling, and it was not unreasonable to say that as long as the ironfounder was making a good, clean grey cast iron, he was giving the enameller something that he could enamel; and if it did not enamel satisfactorily, then it was the fault of the enameller.

Importance of Silicon

Continuing, Mr. Cowan said that the percentage of silicon was of importance in cast iron in relation to the enameller, and it was becoming the habit for the enameller to ask what was the silicon content of the cast iron supplied to him. At the same time, it was not the universal practice for the enameller to concern himself too seriously with the silicon content, and very often he had no idea what it was. If he were asked, he would probably say 2½ per cent., whereas it might be over 3 per cent. or under 2 per cent. As a matter of fact, owing to the conditions he had mentioned regarding the lack of supplies of suitable pig-iron, there were foundries in Falkirk which had been making castings which had enamelled satisfactorily con-

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BILL: "I say, Tom, just look at that, that's what I call a first-class enamelling job!"

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BILL: "Well, I've been in the business a good few years now and I've never worked with anything to equal their materials—there's no trouble with them and the finish is wonderful."

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OPORTO (Portugal)
TEPLITZ SCHONAU
(Czecho Slovakia)

B 1.

taining anything from 1.9 to 2.7 per cent. silicon, and no abnormality had been noticed in the enamelling properties. At the temperature of enamelling he did not think there was any danger of the silicon taking the oxygen from the enamel, forming silica and leaving a metallic oxide, and he did not know of any evidence of chemical reaction of this sort.

Carbon Content and Annealing

Referring to carbon, Mr. Cowan said the amount of work done in this country and also in Germany and America made him very sceptical to speak about the influence of carbon in cast iron on the enamel. A great deal of work had been done in this connection in America by Poste, Krynitsky and Harrison, and also by other workers in Germany, all of which was so contradictory that it was very difficult to believe which was right. In such circumstances it was usually the best thing to decide according to one's own common sense, and almost inevitably common sense gave the right answer.

Considering as an example the cast-iron bath, Mr. Cowan said the surface area of such a bath in relation to the amount of metal used was sufficient to justify one referring to a bath as consisting wholly of area. The total carbon was from 3.2 to 3.4 per cent., with approximately 3 per cent. graphite. This was 3 per cent. graphite by weight, and the specific gravity of graphite was approximately 2, whereas the specific gravity of cast iron was approximately 7, so that a graphite content of approximately 3 per cent. by weight was practically 10 per cent. by volume. Therefore, one-tenth of every casting consisted of graphite, which was spread throughout the whole of the bath. Being so spread, however, and since it was relatively a very small proportion of the total surface area of a bath which was defective—if at all—it could not reasonably be said that graphite resulted in pinholes and blistering during enamelling.

It was true that annealing benefited the enameller, but what happened to cast iron when it was annealed? The combined carbon broke up and there was a precipitation of carbon which he called graphite. Some people called it primary carbon or primary graphite, but at all events it was precipitated carbon and was precipitated by the decomposition of pearlite, but it was not necessarily in a more active condition than the original graphite. Dr. Norbury, in a very ingenious but simple experiment, once enamelled a chunk of graphite, and he certainly got a bubbling effect for the first few moments when the graphite was in contact with the enamel, which was the typical Mauson effect; but, said Mr. Cowan, he did not think it was reasonable to assume that carbon, whether combined or graphite, reacted with enamel, and having regard to the large surface area of a bath he did not think it could be said that the chemical reaction of this combined carbon or graphitic carbon had anything to do with enamelling defects.

The Ideal Composition

A reliable authority had given the following as the ideal analysis for a light casting for enamelling purposes:—Total carbon, 3.5 to 3.7 per cent.; silicon, 2.5 to 3 per cent.; manganese, 0.3 to 0.5 per cent.; sulphur, 0.06 to 0.09 per cent., and phosphorus, 1.4 to 1.8 per cent. When he had looked at this analysis he was very envious, because he wondered how these percentages of carbon were obtained in relation to the silicon and phosphorus. It was very convenient to have high percentages of total carbon, silicon and phosphorus, but it was necessary to take into consideration the conditions of melting in the cupola. Assuming, however, that this analysis gave a material capable of easy working, he suggested the reason for it was that the coefficient of expansion most nearly approximated to the average coefficient of expansion of typical enamels used in the wet process. Therefore, he could recommend that analysis and, as a matter of fact, thousands of castings had been made in accordance with it and had given excellent enamelling results.

The American Ideal

The Americans had recently met and decided, in so far as it was humanly possible, by getting the best American brains together, to put forward to the American enamelling industry what they considered to be an ideal analysis for cast iron, and it was as follows:—Total carbon, 3.4 per cent. (3 per cent. graphite and 0.4 per cent. combined); silicon, 2.5 per cent.; manganese, 0.6 per cent.; sulphur, 0.08 per cent.; phosphorus, 0.7 per cent. This analysis and also the one he had previously mentioned were both good for enamelling because they produced good clean grey light castings, although he did not like the American analysis so well, because they could not get a higher phosphorus content than approximately 0.7 per cent. Having been given a good casting, it was for the enameller to see that his enamelling process was satisfactory.

Foundry Troubles

Continuing, Mr. Cowan referred to some of the troubles of the ironfounder, and said there were two particular troubles, namely, gases and dirt inclusions. Gases in cast iron could be occluded gases or result in oxides, nitrides, etc., as a result of chemical combination. It was necessary to consider, therefore, what were the conditions which permitted of gases existing in the cast iron.

Speaking of inclusions, he said that iron oxide might be more often than not silica inclusions. When there was a non-metallic substance in suspension in a liquid metal, where the coefficients of expansion and contraction were different, there would be a small space between the particle and the metal when it became solid. The fact that they were different materials with different mechanical properties meant that when the cast iron was set, the inclusions in the solid cast iron must have round about them a small space occupied by gas. He was not concerned at the moment with what gas this might be, whether it was hydrogen or nitrogen. It might be air, but he suggested that that was a potential source of gas, namely, a physically entrapped gas in the metal rather than a gas due to chemical reaction between the oxides of the enamel and the constituents of the cast iron.

General and Local Defects

Referring again to his original example of a bath, he said that if chemical combination were producing gas he would expect to see the whole surface of the bath blistered; but if only part of the surface were blistered, it was reasonable and rational to attribute it to inclusions in the metal at that part; there might be some entrapped gases.

He had been asked whether coarse graphite or fine graphite was the better. The difference between the expansion coefficients of the two substances implied that there would be a small space between the flake of graphite and the metal. That space was not a vacuum, but contained gas. No matter what gas it was, it would come out when it was heated. Was not that the more rational way of visualising the evolution of gas from cast iron? In other words, was it not the porosity of cast iron which was responsible for pin-holing, bubbling, and so forth? Surely, the fact that particular areas in a casting gave trouble, rather than the whole casting, was in keeping with the theory of differences in porosities? If there were a damp spot in the sand in which the casting was moulded there would be possibly a chill at that point; and any attempt to enamel chilled iron would give the "bubbly" effect, due to the escape of the entrapped gases.

If the cast iron were annealed, however, one could produce a satisfactorily enamelled casting. People had told him that, in spite of the fact that they had annealed a casting, it had not enamelled well, and they had attributed their difficulties to the composition; they would say that the combined carbon content was too high. The enameller must appreciate that the structural change resulting from the application of heat to cast iron, steel or any other metal, required time. If a white cast iron were annealed it would permit of enamelling, but if it were not annealed it would be "bubbly." Instead of complaining of the condition or the composition of the cast iron, the enameller should apply his knowledge to overcoming the defects in the cast iron, which perhaps for the time being had been beyond the ken of the ironfounder.

How Co-operation Helps

The ironfounder could not guarantee to give exactly similar castings each day; therefore, one would like to see closer relationship between the ironfounder and the enameller, so that if the ironfounder varied his material he could give the enameller the tip, and the latter was then in a good position to decide whether to increase or decrease the annealing time or to vary any other treatment. After all, annealing had the great advantage that it extended the greying action of the silicon. If the silicon content were much higher than the normal, one could save something on annealing; but if the silicon content were much lower than the normal, a little extra annealing was necessary. The enamellers should not be content to adopt a definite time of annealing for all the castings and for all occasions, and then, if some of the castings gave bad results in enamelling, to ask what on earth the foundry was doing! He was trying to encourage the ironfounders to ask what on earth the people in the enamelling shop were doing!

A very earnest and efficient enameller in Scotland had stated publicly at a recent meeting in Glasgow that whenever he was in difficulties with regard to castings which were to be enamelled, he did not bother about the analysis of the cast iron, but changed his enamel. That man had the courage of his convictions, and his statement was worth thinking about; he was of the opinion that the analysis of the iron had nothing to do with the enamelling results, and he had a quantity of different enamels available in his shop.

The ironfounder was doing all he possibly could to make a good casting. One could not expect the condition of a foundry to be such as that of a drawing room, by reason of the nature of the work carried out there; but Mr. Cowan wanted the enamelling shop to be something like a drawing room.

Whenever enamellers or ironfounders or members of the public generally looked at anything which was enamelled they looked for trouble; they invariably found it, of course! The slightest defect in an enamelled product was dangerous from the point of view of the producer. A defect of similar proportions in cast iron, on the other hand, did not mean anything. There could be millions of minor defects in castings; one had only to examine a casting under an ordinary pocket lens to realise that from the point of view of nice skin the peach had it every time!

How Defects Arise

At a recent lecture in Glasgow a very fine illustration had been shown of innumerable black spots in enamel, due to dirty conditions in the enamelling shop. The lecturer on that occasion had shown a very light brown line or thread in the enamel; before enamelling a batch he had taken out that thread, and had proved to his own satisfaction, by chemical analysis, that it had consisted of material identical with that contained in a series of bags stored in a place 100 yds. away. That might appear to be a little far-fetched; but the gentleman concerned was a very efficient enameller, and Mr. Cowan agreed with his conclusion.

At one works near London the men were actually carrying sand and rubbish from the

(*Concluded on page* 130.)

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ACTUAL ANALYSIS CERTIFICATES ARE AVAILABLE WITH EACH DELIVERY

Typical Cylinder Pig Iron Specification

TOTAL CARBON	2·70%
SILICON	1·80%
MANGANESE	·90%
SULPHUR	·06%
PHOSPHORUS	·40%

Typical Malleable Pig Iron Specification

TOTAL CARBON	2·60%
SILICON	·75%
MANGANESE	·50%
SULPHUR	·05%
PHOSPHORUS	·06%

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The Week's News in Brief

Trade Talk

BROOM & WADE, LIMITED, air-compressor and pneumatic-tool manufacturers, of High Wycombe, are making extensions to their iron foundry.

THE ANNUAL STAFF DINNER of Harper, Phillips & Company, Limited, engineers and ironfounders, of Grimsby, was held in Grimsby recently. Mr. E. A. Phillips (managing director) presided.

THE MONOMETER MANUFACTURING COMPANY, LIMITED, of Savoy House, Strand, London, W.C.2, has recently installed for Metal Products Company (Willenhall), Limited, a "Monometer" oil-fired semi-rotary furnace of 1,000 lbs. capacity.

THE SEVENTEENTH biennial dinner of the Sheffield Society of Engineers and Metallurgists will be held on March 22 at the Royal Victoria Station Hotel, Sheffield. Engineer Vice-Admiral Sir Harold A. Brown, K.C.B., Director-General of Munitions Production, is to be the principal guest.

MR. A. N. MCQUISTAN, director and general manager of the South Durham Steel & Iron Company, Limited, opening a works athletic club at Middlesbrough on Saturday, announced that a fortnight's holiday with pay would be given this year to all employees of the company and its associated concern, the Cargo Fleet Iron Company, Limited.

THE BRITISH NON-FERROUS METALS RESEARCH ASSOCIATION, in co-operation with the Swedenborg Society, will shortly publish a translation of Swedenborg's famous treatise on copper, "De Cupro," originally published in Latin in 1734. No translation has hitherto appeared. This book gives an account of the smelting and refining of copper as practised in many countries at the time; the production of brass; the nature of copper ores and their assaying; and various other matters pertaining to copper and its alloys.

HOW THE high-frequency electric crucible process first came to be applied in the manufacture of fine tool steels was recalled by Mr. C. K. Everitt, chairman of Edgar Allen & Company, Limited, in the course of a lecture before the Junior Institute of Engineers recently. About the year 1925, said Mr. Everitt, he visited a works at Bilston where a group of small electric furnaces of the induction type were making high nickel alloy for special wire for electric cables. There were 40 of these furnaces, each of which produced 17 or 18 lbs. of metal in 15 or 20 mins. The furnaces were the invention of Dr. Northrup of America. Mr. Everitt was much impressed by the rapidity of melting and the ease and comfort with which the work could be carried out, and he told Mr. Campbell, who had the matter in hand and who was associated with the late Dr. Heroult, that if he could supply a furnace of 400 or 500 lbs. capacity, Mr. Everitt would suggest to his firm that it should be installed at his works. Shortly afterwards, Mr. Campbell informed the speaker that he was prepared to instal such a furnace, and the furnace was eventually put into operation in 1927, and was the first in the world of this type to be used for the manufacture of high-grade tool steels.

The Analysis of Cast Iron Suitable for Vitreous Enamelling

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rumblers through the enamelling shop! If anything went wrong with the enamelling there, no doubt the enamellers would at once ask what the foundry was doing; they would conclude that the cast iron was wrong, and would perhaps suggest that the fault lay with the sulphur content, which was above 0.1 per cent.!

In a number of works the castings were delivered to the enamelling shop and were annealed immediately, there being no inspection of the castings to ensure that they were sound before annealing. Sometimes they were found to be cracked after annealing; but if only one minute were devoted to their inspection before annealing they might have been found to be cracked, and the time and expense of annealing might have been saved.

Sand-Blasting the Criterion

To consider only the analysis of the cast iron in relation to enamelling was rather like asking a man merely to walk along the Strand and then to write an essay on London. The greatest troubles arising in enamelling were not due to the composition of the iron, but to sand-blasting, because the average sand-blaster had never seen a properly sand-blasted casting! It was his practice always to study the sand-blasting conditions when trouble occurred in enamelling. The purpose of sand-blasting was to clean the castings. What was meant by "cleaning"? He had been asked from time to time whether he sand-blasted castings at 30 or 90 lbs. per sq. in. pressure, whether he used the centrifugal shot-thrower or the ordinary sand-blast, and whether he used chilled-iron shot or sand. He did not mind what was used, so long as the castings were really clean.

Finally, in order to prove the points he had made, he said that if any members of the Institute experienced trouble in enamelling a sound, clean, grey-iron casting, or believed that it could not be enamelled, and if they would send it to him at Falkirk, he believed he could send it back beautifully enamelled.

Personal

MR. GEORGE PATE, who has completed 25 years as manager of the Carron Company, was made the recipient of an illuminated address at the annual staff dinner of the company at Larbert.

MR. W. J. HATCHLEY has been appointed a director of Clifford Christopherson & Company, Limited. He has been associated with the company since 1918, and has been in charge of the borax department for over 16 years.

MR. WILLIAM THOMSON, a director of John Williams & Company (Wishaw), 1922, Limited, of Wishaw, who joined the firm when a boy fifty years ago, has been presented with an inscribed silver salver and a cheque to commemorate his jubilee. The presentation was made by Mr. T. B. Corbett (managing director) at the annual staff dance.

MR. H. MCNAIR, chief chemist and metallurgist with Smith & Wellstood, Limited, Bonnybridge, has been appointed to the technical executive of Richmond's Gas Stove Company, Limited, Warrington, which belongs to Radiation, Limited. Mr. McNair has acted as honorary secretary of the Falkirk Section of the Institute of British Foundrymen for the past four years.

AFTER 18 YEARS' SERVICE with the Planet Foundry Company, Limited, of Audenshaw, Mr. A. J. D. Black, technical manager, has left to take up a similar appointment with Shanks & Company, Limited, of Barrhead, near Glasgow. On Thursday last Mr. Black received a handsome silver tea service, as the gift of the employees of the Planet works. It was presented to him by Mr. R. Archibald, general manager.

Obituary

MR. ALBERT SHAW, director and manager of William Whittaker & Sons, Limited, Sun Ironworks, Oldham, died on January 26 at the age of 51.

THE DEATH has occurred of Mr. G. Davidson, who was for 33 years in the service of Alex. Shanks & Son, Limited, engineers and ironfounders, of Arbroath.

MR. WILLIAM B. TATE, North of England manager for Cochran & Company (Annan), Limited, boiler makers and iron and non-ferrous founders, of Annan, died suddenly in Newcastle following a seizure.

MR. JACK SMITH, a representative of Samuel Osborn & Company, Limited, Sheffield, in Derbyshire and a portion of the West Riding, has died at his home at Morthen. Mr. Smith became manager of the rolling mills and later works manager for Bury & Company, Limited, during the war. In 1919, he joined Samuel Osborn & Company, Limited.

Contracts Open

Cardiff, February 14.—House service meters; e.h.t. and l.t. paper insulated cables, for the Town Council. The City Electrical Engineer, The Hayes, Cardiff.

Leeds, February 19.—Supply and erection of three-phase switchgear for the Town Council. Mr. C. Nelson Hefford, City Electrical Engineer, 1, Whitehall Road, Leeds, 1. (Fee £2 2s., returnable.)

Bletchley, February 8.—Provision and laying of 4,000 yds. of 9-in. internal dia. spun-iron class "B" water main, for the Urban District Council. Mr. A. Bates, Council Offices, Bletchley, Bucks. (Fee £2 2s., returnable.)

Braintree, March 2.—Provision and laying of 23 miles of spun-iron water mains from 9 in. to 3 in. dia., for the Rural District Council. Mr. H. E. Fellows, deputy clerk, Council Offices, St. Peter's Close, Bocking, Braintree, Essex. (Fee £5 5s., returnable.)

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Twinco, Limited, Leominster Works, Lower Essex Street, Birmingham.—Capital, £10,000. Manufacturers of, and dealers in, injection and pressure mouldings, metal makers and founders, etc. Directors: G. A. Laughton, G. S. Laughton, H. Loshak and M. Epstein.

N. W. (Locomotives), Limited.—Capital, £200. To acquire the goodwill and all or part of the property or assets of the business of manufacturing and dealing in locomotives, spare parts, etc., carried on by Nasmyth Wilson & Company, Limited. Directors: C. Hardy, 37, Tavistock Square, London, W.C.1, and D. E. Holden.

Forthcoming Events

FEBRUARY 8.

Institute of Metals (Swansea Section):—"Industrial Furnaces," Paper by J. Fallon, at Y.M.C.A., Swansea, at 6.30 p.m.

FEBRUARY 9.

Manchester Association of Engineers:—Inaugural "Manchester Association of Engineers Annual Lecture." "Crystallography and the Engineer," by Sir William H. Bragg, at College of Technology, Manchester, at 7.30 p.m.

FEBRUARY 10.

Institute of Welding (Liverpool Branch):—"Oxy-Acetylene Cutting of Steel and Cast Iron by Hand and Machine," Paper by C. G. Bainbridge, at City Technical College, Byrom Street, Liverpool, at 7.30 p.m.

FEBRUARY 11.

Institute of Metals (Sheffield Section):—"Large Non-Ferrous Castings," Paper by J. E. Newson, at Applied Science Department of the University, St. George's Square, Sheffield, at 7.30 p.m.

Institute of British Foundrymen

FEBRUARY 7.

East Anglian Section:—Joint meeting with Norwich Engineering Society. "Melting of Cast Iron in the Rotary Furnace," Paper by S. E. Dawson, at Stuart Hall, Norwich.

FEBRUARY 8.

Burnley Section:—"Some Aspects of Loam Moulding," Paper by A. J. Hinton, at Municipal College, Ormerod Road, Burnley, at 7.30 p.m.

FEBRUARY 12.

East Midlands Branch:—Joint meeting with Lincolnshire Section. "Melting of Cast Iron," Paper by S. E. Dawson, at University College, Nottingham, at 6 p.m.

Scottish Branch:—"Impressions of Modern Ironfoundry Practice in the U.S.A.," Paper by Dr. A. B. Everest, at Royal Technical College, Glasgow, at 4 p.m.

West Riding of Yorkshire Branch:—"Steam Pressure Feeding," Paper by Ben Hird, at Technical College, Bradford, at 6.30 p.m.

The Institute of Vitreous Enamellers

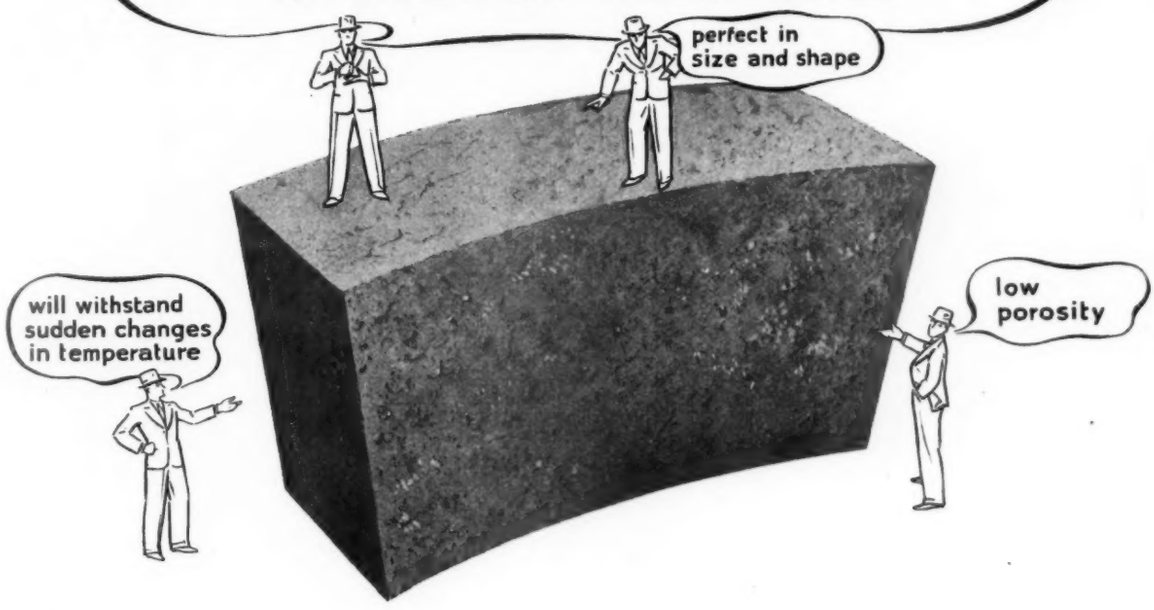
FEBRUARY 9.

Northern Section:—"Transfers suitable for Vitreous Enamelling and their Application," Paper by P. S. Mecrate-Butcher, at Queen's Hotel, Manchester, at 7.30 p.m.

FEBRUARY 10.

Midland Section:—Paper by P. S. Mecrate-Butcher, as above, at Chamber of Commerce, New Street, Birmingham, at 7.30 p.m.

Reliability - is certainly the word to describe these bricks



You can safely rely on the firebricks supplied by The General Refractories Group of Companies giving you satisfaction in every respect. They withstand high temperatures and sudden changes of heat without melting or splitting, and their low porosity enables them to resist abrasive forces and slag action. The utmost care is taken in the production of both standard sizes and special shapes, so that they are always of the same high quality.

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MANCHESTER OFFICE: 9, Albert Square. Telephone: Blackfriars 6130 Telegrams: "Genefax, Manchester." (Mr. S. G. Throssell).

MIDDLESBROUGH OFFICE: Halifax Bldgs., Exchange Place, Telephone: Middlesbrough 3313. Telegrams: "Genefax, Middlesbrough." (Mr. J. A. Williams).

CARDIFF OFFICE: 17, Windsor Place, Telephone: 5796. Telegrams: "Genefax, Cardiff." (Mr. F. E. Rutter).

Raw Material Markets

Consumers of foundry pig-iron still show little interest in new business. Supplies can be obtained without much difficulty in most districts. The absence of new inquiries is not causing any great concern; the opinion that trade is on the decline is discounted generally, and the reason may well be that consumers do not deem it necessary to book ahead while the supply position is satisfactory.

Pig-Iron

MIDDLESBROUGH.—Producers in this area are despatching supplies against old contracts quite freely, and users now have no complaint in this respect. Despite the fact that it is possible to take up additional supplies for early delivery, consumers have displayed little desire so to do, and new business is slow to materialise. For delivery to Middlesbrough or Falkirk, No. 3 Cleveland G.M.B. iron is quoted at 109s., elsewhere on the North-East Coast at 111s., and at 112s. on Clydeside. No. 1 foundry iron is quoted at 2s. 6d. per ton above the foregoing prices. Business in hematite generally is restricted to deliveries up to the end of June, and not much has been done beyond that period, despite the fact that prices have been stabilised for the whole of the year. Makers have good order-books on home account, but export trade is quiet. For delivery on the North-East Coast, East Coast mixed numbers are quoted at 132s. 6d., with No. 1 quality at 133s., less 5s. rebate.

LANCASHIRE.—Producers have quite well-filled order-books and are making satisfactory deliveries under contracts. In some cases, consumers are calling for additional tonnages in order to build up stocks. Activity among light-castings makers and manufacturers of textile machinery is still on the quiet side. For delivery in the Manchester price zone, Derbyshire and Staffordshire No. 3 is quoted at 114s., with Northamptonshire at 112s. 6d. and Derbyshire forge iron at from 111s. to 113s. No. 3 Scottish foundry is quoted at 141s., West Coast hematite 141s., and East Coast hematite 140s. 6d., subject to 5s. rebate, for delivery in the Manchester district.

MIDLANDS.—There can be no doubt that business has declined recently in this area. Consumers of iron are less active, and consequently do not desire to book too far ahead. Stocks have been accumulated both at the furnaces and at the users' end, while quite substantial tonnages have been despatched to other districts, although it is possible that this may soon cease, as the improvement in the supply position appears to be general. For delivery to Birmingham and Black Country stations, ordinary foundry iron is quoted at £5 8s. 6d. for Northants No. 3 and £5 11s. for Derbyshire No. 3, subject to 5s. rebate. Hematite is quoted at £7 3s. 6d. for East Coast No. 3 and 1s. more for West Coast. Ordinary grades are in good supply, although special qualities are still somewhat scarce. Consumption of low-phosphorus iron is heavy, and appears to be increasing. The price of this grade varies from £6 7s. 6d. to £7 10s., owing to the fact that supplies are received from a wide area.

SCOTLAND.—There is a good tonnage of iron available for new business, but the demand is quiet. At this time last year, in fact, during the whole of the year, demand was insistent, but supplies were scarce; to-day the opposite appears to be the case. No. 1 foundry is quoted at 120s. 6d., with No. 3 at 118s., f.o.t. furnaces. No. 3 Cleveland is still quoted at 109s. f.o.t. Falkirk and 112s. f.o.t. Glasgow, less 5s. rebate. Hematite mixed numbers are at 133s., with Scottish basic at 107s. 6d., and English and Indian basic at 100s., less 5s. rebate, and including delivery to local steelworks, which continue to be active.

Coke

Only a small amount of business is going through each week, as most consumers already have covered their winter requirements. For delivery to Birmingham and district, best Durham foundry coke is quoted at 55s. 9d. per ton, with Welsh coke at 55s. upwards, according to grade and analysis.

Steel

Great activity continues to rule in the steel industry, although the volume of new business is still rather light, says the official report of the London Iron and Steel Exchange. Consumers have recently shown more inclination to cover themselves forward. The steelworks have enough work in hand to keep them busy for some months to come and are being subjected to considerable pressure from users for delivery. There is little stringency now in the semi-finished steel market, and most of the consuming works are able to operate at capacity. The British works producing this material, however, are still hard pressed to meet all their customers' requirements. In the finished steel section, there is considerable pressure on the part of consumers to obtain delivery against contracts, and in many cases the works are heavily in arrears. The position in this respect, however, seems gradually to be improving. Export business remains quiet, but inquiry from several overseas markets appears to have broadened since the beginning of the year.

Scrap

The demand from steelmakers for scrap suitable for their requirements is heavy, but producers are now more easily able to meet the inquiries and little reliance has now to be placed upon imported material. Generally, the steelworks are taking up the heavier and better grades. Ironworks are rather less active, and the demand for scrap from this source is on the quiet side.

Metals

The situation in the United States has had a disturbing influence on business in this country for a considerable time past, and the recent speech by President Roosevelt has caused the outlook to become still more uncertain.

Copper.—The tone of this market throughout the first month of the year has not been at all encouraging. Buying has been small and prices have tended downwards. Owing to the generally uncertain outlook, consumers have little confidence in the metal and prefer to await events before committing themselves further. There is little improvement in the American situation, which continues adversely to affect the market in this country also. Price changes in the United States continue to be made with monotonous regularity. Since our last report, a leading Customs smelter has reduced the price for domestic copper from 10.25 cents to 10 cents per lb., while some copper for export was sold on Monday at the enhanced price of 9⅞ cents per lb.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £39 8s. 9d. to £39 10s.; Friday, £39 5s. to £39 6s. 3d.; Monday, £38 17s. 6d. to £39; Tuesday, £39 12s. 6d. to £39 13s. 9d.; Wednesday, £39 16s. 3d. to £39 17s. 6d.

Three Months.—Thursday, £39 13s. 9d. to £39 15s.; Friday, £39 10s. to £39 11s. 3d.; Monday, £39 2s. 6d. to £39 3s. 9d.; Tuesday, £39 16s. 3d. to £39 17s. 6d.; Wednesday, £40 1s. 3d. to £40 2s. 6d.

Tin.—The January Statistical Bulletin of the International Tin Research and Development Council, published by The Hague Statistical Office, estimates that world apparent tin consumption in December, at 13,100 tons, was slightly below that in December, 1936. Consumption in 1937, calculated by subtracting exports from imports and/or production, with adjustments for changes in stocks, so far as the necessary information is available, amounted to about 181,500 tons. However, it is expected that when all the necessary data are available, the consumption will prove to be appreciably higher, due to the fact that exports of tin from smelter countries are not all accounted for in the import returns of consuming countries. The difference now amounts to some 13,000 tons, which would bring the consumption figure for 1937 to about 194,000 tons. World tinplate production in December amounted to 263,000 tons, against 321,000 tons in December, 1936. The total 1937 output shows a record figure of 4,020,000 tons, being an increase of 300,000 tons as compared with the preceding year. Tinplate production now is 50 per cent. larger than ten years ago; the industry's output has nearly doubled within a period of fifteen years. Visible stocks at the end of December amounted to 25,711 tons, against 22,695 tons a year ago. It happened to be that the stocks at the end of 1936, as well as those at the end of 1937, amounted to 14.2 per cent. of tin consumption in the respective years.

The Batavian newspaper, "Nieuws Van den Dag," recently published a report to the effect that negotiations regarding a tin buffer stock had reached so advanced a stage that an agreement on principle might soon be reached. It was understood that the pool would be controlled by persons wholly independent of producing and consuming interests, although definite plans had not been submitted to the respective Governments. Referring to the same report, a message from Amsterdam states that if any progress has been made, this will not come to the fore until the delegates of the International Tin Committee meet at The Hague on February 18, when a definite decision may only then be achieved if Malayan producers adopt an entirely different attitude than hitherto.

The tin market during the past week has been dull. In the United States, it is believed that tinplate mills are operating at around the low figure of 35 per cent. of normal capacity.

Official quotations were as follow :—

Cash.—Thursday, £178 17s. 6d. to £179; Friday, £177 to £177 5s.; Monday, £177 15s. to £178 5s.; Tuesday, £180 10s. to £180 15s.; Wednesday, £182 to £182 5s.

Three Months.—Thursday, £179 10s. to £179 15s.; Friday, £177 10s. to £177 15s.; Monday, £178 10s. to £178 15s.; Tuesday, £180 15s. to £181; Wednesday, £182 5s. to £182 15s.

Spelter.—Despite a weak demand, the tone in this market has been comparatively firm. Supplies of high-grade zinc are still scarce, while there has been some increase in the demand for g.o.b.'s. The world production of slab zinc during December, as reported by the American Bureau of Metal Statistics, was 161,600 tons, compared with 157,900 tons in November.

Daily market prices :—

Ordinary.—Thursday, £14 11s. 3d.; Friday, £14 10s.; Monday, £14 11s. 3d.; Tuesday, £14 12s. 6d.; Wednesday, £14 15s.

Lead.—While lead-consuming industries are fairly well employed on the whole, new business is not plentiful. Considering all things, the outlook over a long period is not really unsatisfactory; consumption is about maintained, and it must not be overlooked that this is generally a quiet period of the year so far as lead is concerned.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £15 10s.; Friday, £15 8s. 9d.; Monday, £15 11s. 3d.; Tuesday, £15 16s. 3d.; Wednesday, £15 15s.

Scrap.—There has been very little business put through during the past week. Prices have receded still further.

Approximate selling prices for old metal :—New aluminium cuttings, £82; rolled, £66; cast, £40; foil, £88 to £92. Copper, £37 to £40; braziery, £35. Brass (clean), £25 to £26. Zinc, £10. Lead, £15. Gunmetal, £40 to £41.

Publications Received

Iron and Steel Trades in 1937. Published by William Jacks & Company, Winchester House, Old Broad Street, London, E.C.2.

This annual review is invariably very intelligently compiled, and covers not only pig-iron and steel but also the non-ferrous markets, the notes on most of which finish with "If . . .," which refers to the American political situation. Of interest to foundry owners are some comments on the operation of the pig-iron loyalty rebate scheme.

Light Metals. Published by the Temple Press, 5, Rosebery Avenue, London, E.C.1. A monthly magazine. Price 1s.

This magazine is designed to cover the extraction of the light metals from their ores, and their working up into articles of commerce. The first issue has indeed set a high standard in technical journalism, and we wish our new contemporary every success.

THE BIRMINGHAM OFFICE of the United Steel Companies, Limited, has been moved from the old Martino Steelworks in Princip Street to modern offices in the centre of the city, at Union Chambers, Temple Row, Birmingham

ALUMINIUM CASTING ALLOYS
for every purpose

The British Aluminium Company produces aluminium alloys individually suited to all requirements. Here is a selection.

BA/Y for extra strong castings

BA/23 for anodising

BA/42 for low expansion pistons

BA/40D for ductile castings

BA/40J for die castings

Consult THE **British Aluminium** CO. LTD

Head Office: ADELAIDE HOUSE, LONDON TELEPHONE: MANSION HOUSE 5561 (7 lines) TELEGRAMS: CRYOLITE, BILGATE, LONDON.

F.T.J. 3/2/38

RAW MATERIALS—PRICE LIST

(Wednesday, February 2, 1938)

COPPER

	£ s. d.
Standard cash	39 16 3
Three months	40 1 3
Electrolytic	44 5 0
Tough	42 10 0
Best selected	43 0 0
Sheets	75 0 0
India	55 12 6
Wire bars	44 5 0
Ingot bars	44 5 0
H.C. Wire rods	47 15 0
Off. av. cash, Jan.	41 8 6½
Do., 3 mths., Jan.	41 12 8½
Do., Sttlmnt., Jan.	41 8 8½
Do., Electro, Jan.	45 16 0½
Do., B.S., Jan.	45 12 6
Do., Wire bars, Jan.	46 4 4½
Solid drawn tubes	12½d.
Brazed tubes	12½d.
Wire	8d.

BRASS

Solid drawn tubes	11¼d.
Brazed tubes	13½d.
Rods, drawn	9½d.
Rods, extd. or rlld.	6½d.
Sheets to 10 w.g.	8½d.
Wire	8¾d.
Rolled metal	8½d.
Yellow metal rods	6¼d.

TIN

	£ s. d.
Standard cash	182 0 0
Three months	182 5 0
English	182 0 0
Bars	184 0 0
Straits	184 0 0
Eastern	182 0 0
Banca (nom.)	—
Off. av. cash, Jan.	183 15 7½
Do., 3 mths., Jan.	184 1 8
Do., Sttlmt., Jan.	183 15 8¼

SPELTER

	£ s. d.
Ordinary	14 15 0
Remelted	12 5 0
Hard	11 15 0
Electro, 99.9	18 7 6
English	15 15 0
India	14 0 0
Zinc dust	22 0 0
Zinc ashes	5 10 0
Off. aver., Jan.	15 1 8
Aver., spot, Jan.	14 19 10¼

LEAD

	£ s. d.
Soft foreign, ppt.	15 15 0
Empire (nom.)	16 13 9
English	18 0 0
Off. aver., Jan.	16 3 10 17/28
Aver., spot, Jan.	16 2 8½

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

	£ s. d.	£ s. d.
Zinc sheets, English	28 0 0	to 28 10 0
Do., V.M. ex-whse.	28 0 0	to 28 10 0
Rods	21 10 0	

ANTIMONY

	£ s. d.	£ s. d.
English	81 0 0	to 82 0 0
Chinese, ex-whse.	68 0 0	
Crude, c.i.f.	41 0 0	

QUICKSILVER

	£ s. d.
Quicksilver	12 17 3

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	12 10 0
45/50%	12 0 0
75%	17 0 0
Ferro-vanadium—	
35/50%	14/- lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	4/9 lb. Mo.
Ferro-titanium—	
20/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£21 to £22
Ferro-tungsten—	
80/85%	6/- lb. (nom.)
Tungsten metal powder—	
98/99%	6/1½ lb. (nom.)
Ferro-chrome—	
2/4% car.	34 15 0
4/6% car.	24 5 0
6/8% car.	24 0 0
8/10% car.	24 0 0
Ferro-chrome—	
Max. 2% car.	36 0 0
Max. 1% car.	38 5 0
Max. 0.5% car.	41 0 0
70% carbon-free	10d. lb.
Nickel—99.5/100%	£180 to £185
"F" nickel shot	£165 0 0
Ferro-cobalt, 98/99%	8/6 to 8/9 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese—	
76/80% loose	£18 15 0 to 19 5 0
76/80% packed	£19 15 0 to 20 5 0
76/80% export	£22 0 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated, basis 2-ton lots.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	3s. 10d.
Finished bars, 18% tungsten	5s. 0d.

Per lb. d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 5/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£ s. d.	£ s. d.
South Wales (West)—		
Heavy steel, best	3 8 9	to 3 11 3
Mixed iron and steel	3 6 9	to 3 9 3
Heavy cast iron	3 8 9	to 3 11 3
Good machinery	3 15 0	to 3 17 6
Cleveland—		
Heavy steel, best	3 7 0	to 3 9 6
Steel turnings	2 13 0	to 2 15 6
Heavy cast iron	4	5 0
Heavy machinery	4 10 0	
Midlands—		
Short heavy steel	4 0 0	
Light cast-iron scrap	3 2 6	
Heavy wrought iron	4 0 0	to 4 5 0
Steel turnings	2 6	3 to 2 8 9
Scotland—		
Heavy steel, best	3 5 0	to 3 7 6
Ordinary cast iron	4 5 0	to 4 7 6
Cast-iron borings	2 0 6	to 2 3 0
Wrot-iron piling	4 5 0	to 4 7 6
Heavy machinery	4 10 0	to 4 12 6

London—Merchants' buying prices, delivered yard.

	£ s. d.
Copper (clean)	32 0 0
Brass	22 10 0
Lead (less usual draft)	13 10 0
Tea lead	10 0 0
Zinc	8 0 0
New aluminium cuttings	71 0 0
Braziery copper	30 10 0
Gunmetal	33 0 0
Hollow pewter	135 0 0
Shaded black pewter	97 0 0

PIG-IRON*

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	111/6
,, No. 3	109/-
,, No. 4	108/-
Forge No. 4	108/-
Hematite No. 1	133/-
Hematite M/Nos.	132/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	133/-
,, d/d Birm.	144/6
Malleable iron d/d Birm.	165/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	110/-
,, No. 3 fdry.	111/-
Northants forge	107/6
,, fdry. No. 3	108/6
,, fdry. No. 1	111/6
Derbyshire forge	110/-
,, fdry. No. 3	111/-
,, fdry. No. 1	114/-
Scotland—	
Foundry, No. 1, f.o.t.	120/6
,, No. 3, f.o.t.	118/-
Cleveland No. 3, Glasgow	112/-
,, ,, Falkirk	109/-
Scottish hem. M/Nos. d/d	133/-
Sheffield (d/d district)—	
Derby forge	107/6
,, fdry. No. 3	108/6
Lincs forge	107/6
,, fdry. No. 3	108/6
W.C. hematite	138/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	114/-
Staffs fdry. No. 3	114/-
Northants fdry. No. 3	112/6
Cleveland fdry. No. 3	114/-
Glengarnock, No. 3	141/-
Clyde, No. 3	141/-
Monkland, No. 3	141/-
Eglinton, No. 3	141/-
Gartsherrie, No. 3	141/-
Shotts, No. 3	141/-

(* Prices of hematite and basic pig-iron, and of foundry and forge iron with a phosphoric content of not less than 0.75 per cent., are subject to a rebate of 5s. per ton under certain conditions.)

FINISHED IRON AND STEEL

Usual district deliveries.

[A rebate of 15/- per ton for steel sections, plates and joists is obtainable in the home trade under certain conditions.]

Iron—	£ s. d.	£ s. d.
Bars (cr.)	13 5 0	to 13 15 0
Nut and bolt iron	11 12 6	to 12 2 6
Hoops	14 2 6	
Marked bars (Staffs) f.o.t.	15 15 0	
Gas strip	14 2 6	
Bolts and nuts, ¾ in. × 4 in.	17 10 0	and up
Steel—		
Plates, ship, etc.	11 8 0	to 11 10 6
Boiler plts.	11 18 0	to 12 0 6
Chequer plts.	13 0 6	
Angles	11 0 6	
Tees	12 0 6	
Joists	11 0 6	
Rounds and squares, 3 in. to 5½ in.	12 0 6	
Rounds under 3 in. to ⅜ in. (untested)	11 9 0	
Flats—8 in. wide and over	11 5 6	
,, under 8 in. and over 5 in.	11 10 6	
Rails, heavy	10 2 6	
Fishplates	14 2 6	
Hoops (Staffs)	12 4 0	
Black sheets, 24g. (4-t. lots)	15 15 0	
Galv. cor. shts. (,,)	18 10 0	
Galv. flat shts. (,,)	19 0 0	
Galv. fencing wire, 8g. plain	20 5 0	
Billets, soft, 100-ton lots	7 17 6	
Sheet bars	7 15 0	
Tin bars	7 15 0	

PHOSPHOR BRONZE

	Per lb. basis
Strip	11d.
Sheet to 10 w.g.	11¼d.
Wire	12¾d.
Rods	13½d.
Tubes	18⅜d.
Castings	15½d.

Delivery 3 cwt. free.
10% phos. cop. £33 above B.S.
15% phos. cop. £38 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	8d. to 1/2
Rolled—	
To 9 in. wide	1/2 to 1/8
To 12 in. wide	1/2½ to 1/8½
To 15 in. wide	1/2½ to 1/8½
To 18 in. wide	1/3 to 1/9
To 21 in. wide	1/3½ to 1/9½
To 25 in. wide	1/4 to 1/10
Ingots for spoons and forks	8d. to 1/4½
Ingots rolled to spoon size	11d. to 1/7½
Wire round—	
to 10g.	1/5½ to 2/0½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/4½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	25.76
No. 2 foundry, Valley	24.00
No. 2 foundry, Birm.	20.38
Basic, Valley	23.50
Malleable, Valley	24.00
Grey forge, Valley	23.50
Ferro-mang. 80%, seaboard	102.50
O.-h. rails, h'y, at mill	42.50
Billets	37.00
Sheet bars	37.00
Wire rods	47.00
	Cents.
Iron bars, Chicago	2.40
Steel bars	2.45
Tank plates	2.25
Beams, etc.	2.25
Skelp, grooved steel	2.10
Steel hoops	2.40
Sheets, black, No. 24	3.15
Sheets, galv., No. 24	3.80
Wire nails	2.75
Plain wire	2.90
Barbed wire, galv.	3.40
Tinplates, 100-lb. box	$5.35

COKE (at ovens)

Welsh foundry	42/6
,, furnace	37/6
Durham foundry	39/6
,, furnace	32/6 to 37/6
Scottish foundry	42/6
,, furnace	40/-

TINPLATES

f.o.b. British Channel ports.

I.C. cokes 20×14 per box	22/6 to 23/-
,, 28×20 ,,	45/- to 46/-
,, 20×10 ,,	34/9 to 35/3
,, 18¾×14 ,,	24/9 to 25/3
C.W. 20×14 ,,	18/- to 19/-
,, 28×20 ,,	36/- to 37/6
,, 20×10 ,,	29/9 to 30/6
,, 18¾×14 ,,	21/- to 21/3

SWEDISH CHARCOAL IRON & STEEL

	£ s. d.	£ s. d.
Pig-iron	£12 0 0	to £13 0 0
Bars-hammered, basis	£20 0 0	to £22 0 0
Bars and nail-rods, rolled, basis	£19 0 0	to £20 0 0
Blooms	£18 0 0	to £19 0 0
Keg steel	£30 0 0	to £35 0 0
Faggot steel	£20 0 0	to £25 0 0
Bars and rods dead soft st'l	£19 0 0	to £20 0 0

All per English ton, f.o.b. Gothenburg
[Subject to an exchange basis of Kr 19.39 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

			£	s.	d.	
Jan.	27	..	39	8	9	dec. 15/-
,,	28	..	39	5	0	,, 3/9
,,	31	..	38	17	6	,, 7/6
Feb.	1	..	39	12	6	inc. 15/-
,,	2	..	39	16	3	,, 3/9

Electrolytic Copper

			£	s.	d.	
Jan.	27	..	43	10	0	dec. 10/-
,,	28	..	43	10	0	No change
,,	31	..	43	0	0	dec. 10/-
Feb.	1	..	43	15	0	inc. 15/-
,,	2	..	44	5	0	,, 10/-

Standard Tin (cash)

			£	s.	d.	
Jan.	27	..	178	17	6	dec. 42/6
,,	28	..	177	0	0	,, 37/6
,,	31	..	177	15	0	inc. 15/-
Feb.	1	..	180	10	0	,, 55/-
,,	2	..	182	0	0	,, 30/-

Tin (English ingots)

			£	s.	d.	
Jan.	27	..	178	17	6	dec. 42/6
,,	28	..	177	0	0	,, 37/6
,,	31	..	177	15	0	inc. 15/-
Feb.	1	..	180	10	0	,, 55/-
,,	2	..	182	0	0	,, 30/-

Spelter (ordinary)

			£	s.	d.	
Jan.	27	..	14	11	3	dec. 2/6
,,	28	..	14	10	0	,, 1/3
,,	31	..	14	11	3	inc. 1/3
Feb.	1	..	14	12	6	,, 1/3
,,	2	..	14	15	0	,, 2/6

Spelter (Electro, 99.9 per cent.)

			£	s.	d.	
Jan.	27	..	18	7	6	dec. 3/9
,,	28	..	18	5	0	,, 2/6
,,	31	..	18	5	0	No change
Feb.	1	..	18	5	0	,, ,,
,,	2	..	18	7	6	inc. 2/6

Lead (soft foreign, prompt)

			£	s.	d.	
Jan.	27	..	15	10	0	dec. 3/9
,,	28	..	15	8	9	,, 1/3
,,	31	..	15	11	3	inc. 2/6
Feb.	1	..	15	16	3	,, 5/-
,,	2	..	15	15	0	dec. 1/3

Lead (English)

			£	s.	d.	
Jan.	27	..	17	10	0	dec. 5/-
,,	28	..	17	10	0	No change
,,	31	..	17	10	0	,, ,,
Feb.	1	..	18	0	0	inc. 10/-
,,	2	..	18	0	0	No change

A COMPARISON OF SCRAP PRICES

Prices of Heavy Steel Scrap (Delivered) in the Principal Districts at the Beginning of Each Month in the Years 1931–1938.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Scotland—													
1931	2 7 6	2 7 6	2 5 0	2 5 0	2 0 0	1 17 6	1 17 6	1 17 6	1 17 6	1 15 0	2 0 0	2 10 0	2 17 3½
1932	2 2 6	2 2 6	2 0 0	1 17 6	1 17 6	1 17 6	1 15 0	1 15 0	1 12 6	1 13 0	1 12 6	2 2 6	2 1 0½
1933	1 15 0	1 17 6	1 18 6	1 18 9	1 18 0	1 17 6	1 18 9	2 0 0	2 2 6	2 5 0	2 7 6	1 15 0	1 16 9½
1934	2 8 9	2 14 3	2 13 0	2 13 0	2 12 0	2 10 0	2 10 6	2 10 6	2 11 0	2 10 9	2 10 0	2 8 9	2 0 7½
1935	2 10 0	2 10 0	2 10 0	2 10 0	2 10 0	2 10 0	2 10 0	2 10 0	2 10 0	2 10 0	2 10 0	2 10 0	2 11 2
1936	2 12 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 1
1937	2 17 6	3 2 6	3 6 0	3 5 9	3 5 9	3 5 9	3 5 9	3 5 9	3 5 9	3 5 9	3 6 3	3 6 3	3 4 9½
1938	3 6 3	—	—	—	—	—	—	—	—	—	—	—	—
North-East Coast—													
1931	2 6 0	2 6 0	2 5 0	2 5 0	2 2 6	2 0 0	1 17 6	1 17 6	1 17 6	1 17 6	1 17 6	2 2 6	2 1 2½
1932	2 0 0	2 0 0	1 15 0	1 15 0	1 15 0	1 15 0	1 15 0	1 15 0	1 15 0	1 12 6	1 15 0	1 17 6	1 15 10
1933	2 0 0	2 0 0	2 5 0	2 0 0	1 15 0	1 17 6	2 2 6	2 2 6	2 3 6	2 5 0	2 7 6	2 7 6	2 2 2
1934	2 10 0	2 16 0	2 10 0	2 7 6	2 7 6	2 10 0	2 9 9	2 10 0	2 10 0	2 10 0	2 11 6	2 11 3	2 10 3½
1935	2 11 6	2 11 9	2 12 0	2 12 0	2 12 6	2 12 6	2 12 6	2 12 6	2 12 6	2 12 6	2 12 6	2 13 9	2 12 4½
1936	2 15 0	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	3 0 0	3 0 0	2 17 8½
1937	3 2 6	3 5 0	3 7 0	3 7 9	3 7 9	3 7 9	3 7 9	3 7 9	3 7 9	3 7 9	3 8 3	3 8 3	3 7 1½
1938	3 8 3	—	—	—	—	—	—	—	—	—	—	—	—
South Wales—													
1931	2 5 0	2 7 6	2 7 6	2 7 6	2 5 0	2 2 6	2 0 0	2 0 0	1 18 0	2 2 6	2 5 0	2 7 6	2 4 0
1932	2 6 6	2 6 0	2 5 0	2 2 6	2 2 0	1 19 0	1 17 6	1 18 6	1 18 0	1 18 0	1 17 6	1 18 0	2 0 8½
1933	2 0 0	2 1 6	2 4 0	2 3 6	2 3 6	2 3 0	2 5 0	2 5 0	2 8 0	2 10 0	2 10 0	2 10 0	2 5 3½
1934	2 10 0	2 16 3	2 15 9	2 13 9	2 14 3	2 15 0	2 14 3	2 14 3	2 15 0	2 15 6	2 15 6	2 15 6	2 14 7
1935	2 15 6	2 15 6	2 15 6	2 15 6	2 15 6	2 15 6	2 15 6	2 15 6	2 16 1½	2 17 9	2 19 8	3 1 1½	2 16 2½
1936	3 2 6	3 5 0	3 5 0	3 5 0	3 5 0	3 5 0	3 3 0	3 2 0	3 2 0	3 4 0	3 4 0	3 4 0	3 3 10½
1937	3 5 0	3 10 0	3 10 0	3 8 9	3 8 9	3 8 9	3 8 9	3 8 9	3 8 9	3 9 9	3 9 9	3 9 9	3 14 7½
1938	3 10 0	—	—	—	—	—	—	—	—	—	—	—	—

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WANTED.—Representatives calling upon non-ferrous foundries for sale of a product manufactured by large company not at present connected with foundry industry. Please give full particulars of area covered, etc., to: MESSRS. C. L. BENCARD (1934), LTD., Hendon, London, N.W.4.

PATENT

THE Proprietors of Letters Patent Nos. 403,768 and 412,058 relating to "Method of Manufacturing Low-Carbon Chromium Alloys" desire to dispose of their patents or to grant licences to interested parties on reasonable terms for the purpose of exploiting the same and ensuring their full commercial development and practical working in this country. Inquiries to be addressed to: CRUIKSHANK & FAIRWEATHER, 65/66, Chancery Lane, London, W.C.2.

PROPERTY

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ROOMS size, 12 ft. by 12 ft., 12 ft. by 9 ft., and 6 ft. by 6 ft.
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Air Receiver, 18 ft. by 4 ft. 6 in.
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MISCELLANEOUS

PATTERNS.—Cleghorn & Co. have new premises at 198-200, Bath Road, Worcester, and are in a better position to cope with all classes of engineers' pattern. 'Phone 264.

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